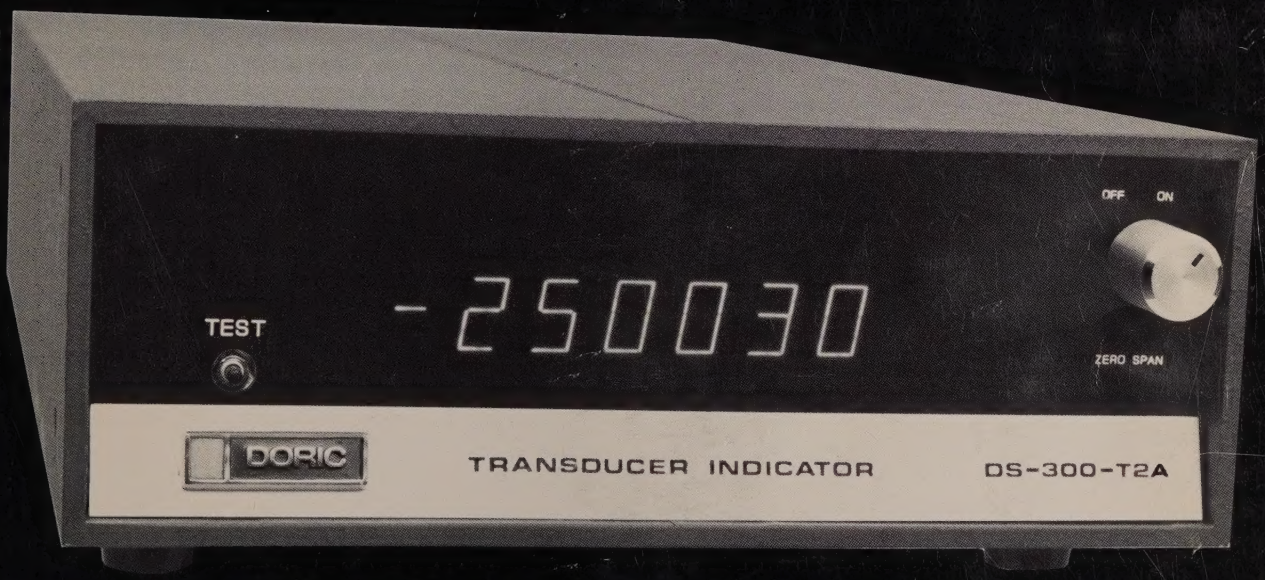
DORIC

OWNER'S MANUAL

DS-300-T2A

DIGITAL STRAIN GAGE TRANSDUCER INDICATOR



MODEL DS 300-T2A

EMERSON
DORIC SCIENTIFIC DIVISION
EMERSON ELECTRIC CO.
3883 RUFFIN ROAD
SAN DIEGO, CA 92123
(714) 565-4415

NOTICE

To comply with the requirements of NBS Handbook H44, the following information must be permanently marked on the front of the indicator. The paragraphs are taken from Handbook H44.

G-S.5.2.4. VALUES. — If graduations, indications, or recorded representations are intended to have specific values, these shall be adequately defined by a sufficient number of figures, words, symbols, or combinations thereof, uniformly placed with reference to the graduations, indications, or recorded representations and as close thereto as practicable, but not so positioned as to interfere with the accuracy of reading.

S.6.1. NOMINAL CAPACITY. — The nominal capacity shall be conspicuously marked as follows:

(a) On any scale equipped with unit weights or weight ranges.

(b) On any scale with which counterpoise or equal-arm weights are intended to be used.

(c) On any automatic-indicating or recording scale so constructed that the capacities of the several individual indicating and recording elements are not immediately apparent.

(d) On any scale with a nominal capacity less than the sum of the reading elements.

S.6.3. FOR LIVESTOCK, VEHICLE, AND RAILWAY TRACK SCALES ONLY. — A livestock, vehicle, or railway track scale shall be marked with the maximum capacity of each section of the load-receiving element of the scale. Such marking shall be accurately and conspicuously presented on or adjacent to the identification or nomenclature plate that is attached to the indicating element of the scale. (Nonretroactive as of 1969.)

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WARRANTY

Doric Scientific hereby warrants each instrument of its manufacture as follows:

1. At the time of delivery of each instrument to the original purchaser, Doric Scientific UNCONDITIONALLY WARRANTS that it shall be free from defects in parts, materials and workmanship; and

2. Commencing with the date of shipments of each instrument to the original purchaser, Doric Scientific UNCONDTIONALLY WARRANTS that each unit shall remain free from defect in parts, materials and workmanship for the period specified below.

In the event any instrument fails to meet the terms of this warranty, Doric Scientific agrees to provide corrective action. Refer to Warranty Claim (below) for proper procedure.

The warranties herein shall not obligate Doric Scientific in any manner whatsoever with respect to, and shall not be applicable to, any defects which after an inspection by Doric Scientific are not to Doric Scientific's reasonable satisfaction demonstrably the result of defective parts, materials or workmanship. We are not liable for consequential damages.

All instruments have a one year warranty except for the following:

5-Year Warranty: DS100-K Series; DS100-P Series

2-Year Warranty: DS100-T Series; DS300-T3; DS305; DS350-T3

For other manufacturer's equipment purchased through Doric, this firm conveys the full warranty of the original manufacturer in respect to duration and degree of coverage.

CERTIFICATION

Doric Scientific certifies that the instrument was thoroughly tested and inspected and found to meet its published specifications when shipped from the factory. Doric Scientific further certifies that its calibration measurements are traceable to NBS.

WARRANTY CLAIM

If either physical damage is found or operation is not within specification when the instrument is received, notify the carrier and Doric Scientific's Customer Service Department (714-565-4415) immediately. In the event the instrument fails to meet the terms of the warranty, Doric's Customer Service should be contacted for a plan of corrective action.

DORIC SCIENTIFIC . . . A DIVISION OF EMERSON ELECTRIC CO.

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$1,395

CUSTOMER DOUGLAS AIRCRAFT Co.
PURCHASE ORDER OCZ176458-9
MODEL NUMBER DS-300-T2A-08-20-21-S6P-13
SERIAL NUMBER 65111
CUSTOMER NUMBER
SHIPMENT DATE 3-81

INSTRUMENT STATUS AT TIME OF SHIPMENT

RANGE 0-20 000
RESOLUTION 1
SYMBOL LBS
BRIDGE EXCITATION 10 VDC
FILTER RESPONSE 4HZ
TARE NA
OVERLOAD TRIP POINT SELECTABLE
R CAL VALUE NA OHMS
R TARE VALUE NA OHMS
R SPAN VALUE 446.88 OHMS

OPTIONS OR ACCESSORIES

☐ HEAVY DUTY LINE FILTER

☐ HIGH SPEED OPTION

☐ FRONT PANEL ZERO (TARE) CONTROL

☒ ISOLATED BCD OUTPUTS

☐ FIXED ZERO

☒ R CAL SWITCH

☐ MODEL DS-305

☐ MODEL TSU

☐ REMOTE PROGRAMMING (USED WITH MODEL TSU)

☐ MOTION DETECTOR
TOLERABLE AMPLITUDE SETTINGS ____ COUNTS
ALLOWABLE TIME SETTING ____ SEC.

☒ ANALOG OUTPUT (OPTION 13)
GAIN 100
R TARE ____ OHMS
R GAIN ____ OHMS

☐ ANALOG OUTPUT (OPTION 13-1)
GAIN ____
R TARE ____ OHMS
R GAIN ____ OHMS

SERIAL NUMBER ____

SERIAL NUMBER ____

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SECTION 1

DESCRIPTION

1.1 GENERAL DESCRIPTION

1.1.1 The Doric Scientific DS-300-T2 is a fully automatic, solid state, digital strain gage transducer measuring instrument. It is capable of monitoring thrust, torque, pressure, force, weight and other physical phenomena and displaying the result directly in engineering units. The instrument includes a microvolt level analog to digital converter, adjustable zero balance and span controls, and provisions for tare offset and calibration resistors. Also featured is a floating excitation power supply for the strain gage bridge, guarded differential inputs and the capability of remote sensing of the bridge excitation voltage. The ratiometric measuring technique and dual slope integrator, combined with a three pole active filter and Doric's automatic zero correction circuitry (AUTO-ZERO), gives the DS-300-T2 the high accuracy and stability needed in many applications.

Depending on full scale requirements, five or six high density digits are used, providing a sharp display of numbers and a decimal point (if needed). Storage circuits hold the display constant between and during each encoding.

The basic readout of the instrument has an active range of ±25,000 counts. Multiplication by a factor of ten is accomplished by activating a six digit (fixed zero), yielding ±250,000. A built-in movable jumper allows internal X1, X2 or X5 selection. X2 allows two digit resolution to ±50,000 and X5 allows five digit resolution to ±(1)25,000, with the leading "1" not displayed. The added fixed zero digit causes those multipliers to be X10, X20 or X50.

In the event the instrument is supplied an input voltage which exceeds its overload setting, a line of dashes appears on the display. A positive overload is indicated by an unbroken line of dashes. A negative overload is signaled by a dash (-) in the leftmost display, followed by a blank and a line of five dashes (-). When the input level returns within limits, the display returns to normal.

A"-" symbol on the readout indicates the minus, or negative polarity. Absence of this symbol indicates the plus, or positive polarity.

The DS-300-T2 is designed to operate from a 115 ± 10 VAC or 230 ± 20 VAC, 50-400 Hz power source. A switch, located on the back panel, selects the operating voltage.

1.2 PHYSICAL DESCRIPTION

The DS-300-T2 is housed in a one piece, extruded, aluminum alloy chassis, giving the instrument a streamlined appearance without sacrificing the importance of rugged construction. The dimensions of the instrument are: 3 inches in height, 8.5 inches in width, 14.5 inches in depth. The unit weighs approximately 11 pounds. The physical size of the DS-300-T2 enables it to be used for bench applications and also rack or panel mounted where a permanent installation is desired. Rack and panel mounting will be discussed in Section 2.3.

1.3 EXTERNAL CONTROLS Ref. Figure 1-1

1.3.1 Power Switch

Power is applied to the instrument by moving the power rotary switch on the front panel from the OFF to the ON position. The power switch is not included if-Option 07, Front Panel Zero (TARE) Control, is included.

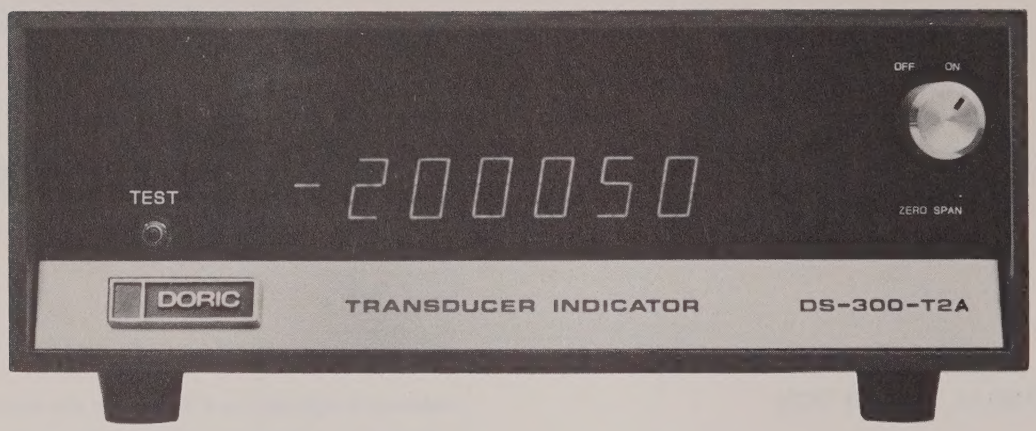


FIGURE 1-1. FRONT PANEL VIEW

1.3.2 Zero and Span Controls

Bridge balance and span are adjusted using the two recessed screwdriver zero and span controls located on the front panel. See Section 5.1 for proper usage.

1.3.3 Front Panel Zero (Tare) Control Option 07)

When incorporated, a rugged, ten turn potentiometer replaces both the standard zero control and power switch. (Power is then applied by plugging in the power cord to the power source.) This control allows ±300 counts zero adjustment at 1μV per count sensitivity, independent of excitation voltage. At 10μV per count, control range is ±30 counts. In general, the range varies inversely with sensitivity.

1.3.4 R Cal Test Switch (Option 08)

When incorporated, depressing this front panel, momentary switch allows an internal, customer supplied, precision resistor to be shunted across one leg of the bridge causing an electrical unbalance which may be considered equivalent to a particular value of mechanical input. This "equivalent mechanical input" may be used for recalibration or checking the instrument's calibration without the necessity of applying a known physical load. See Section 5.6 for further R Cal information.

1.3.5 Input Connector J2

Located on the rear panel Connector J2 is the input to the DS-300-T2. Connection of the transducer is done using this 14 pin Amphenol connector (57-40140). Also contained in this connector are the output pins for the analog output option. Pin information is shown in Figure 1-3.

1.3.6 BCD Connector J1

This 36 pin Amphenol connector (57-40360) carries all BCD information including remote programming from Doric accessory Model TSU, Transducer Switching Unit. Pin information is shown on Figure 1-3.

1.3.7 DS-305 Connector J9 (Option)

When the Model DS-305 is incorporated to work with the DS-300-T2, Connector J9 (Amphenol 57-40240) on the rear panel provides the input/output connection. It is important to note that disconnecting the DS-305 from this connector will render the DS-300-T2 inoperative. For information regarding testing of the DS-300-T2 with the DS-305 disconnected, refer to Section 6.4 for "By-Pass-Connector" information. Pin information is shown in Figure 1-3.

1.3.8 Power Fuse

Mounted on the rear panel in a removable fuse holder, the power fuse for 115V operation is a . 50 amp Slo Blo, for 230V operation a .25 amp Slo Blo.

1.3.9 115/230 VAC Switch

A 115/230 VAC selection switch is located on the rear panel near the fuse. In the upper position, the switch is set for 115 V operation.

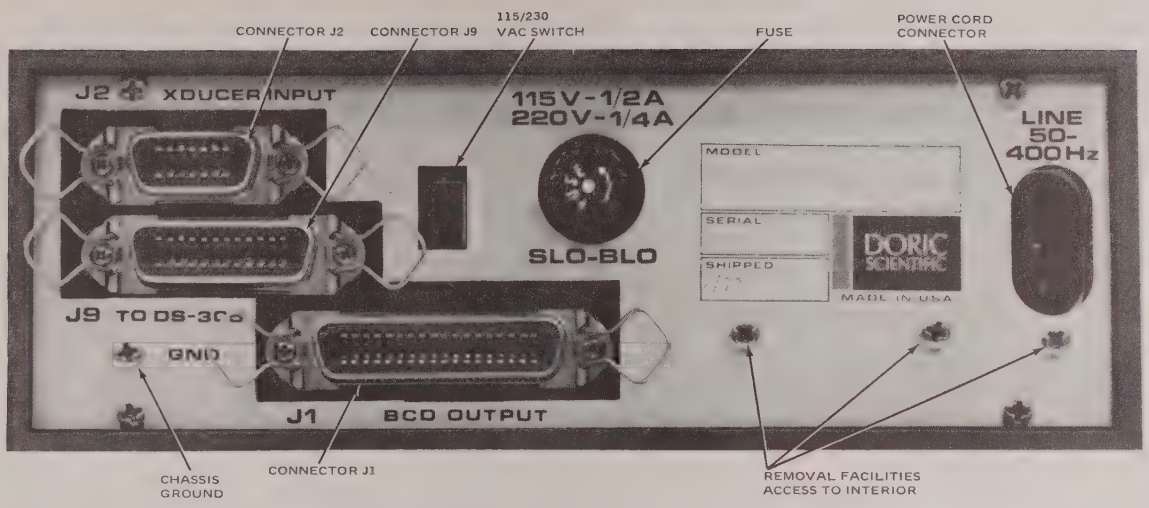


FIGURE 1-2. REAR PANEL VIEW

1.4 PERFORMANCE SPECIFICATIONS

Power Requirements

115 ± 10 VAC, 50-400Hz or 230 ± 20 VAC, 50-400Hz.

An RFI line filter is included to protect the instrument from normal power line transients.

Warm-Up Time

Performance to full accuracy 30 minutes from initial turn on. With Analog Output (Option 13, 13-1) warm-up time is 2 hours.

Accuracy

± 0.02% or reading, ± 0.01% of full scale (10,000 counts).

± 0.02 microvolts with ± 10% AC line variation for 24 hours at 77° F ± 2° F ambient temperature.

Sensitivity and Resolution

Maximum sensitivity and resolution of 1 microvolt per active count. Resolution of 1 part in 25,000 in basic unit.

Repeatability

± 2 microvolts or ± 0.01% of range, whichever is greater.

Zero Stability

No zero drift with time; temperature stability - zero better than 0.5 microvolts/°F.

2,000 to 20,000 active counts on a count-by-one setting.

Input Characteristics

Fully guarded differential measurement circuit with high intrinsic common mode rejection, allowing grounded (earth) or floating strain gage transducers. Measurement circuits are floating with respect to earth ground.

Input Impedance

Greater than 50 megohms at all times; usable with 1K ohm bridge impedance.

Measurement Technique

Automatic, self zeroing, true dual slope integration ratiometer with no preamplifiers. Potentiometric input; E_X/E_{ref} switching is performed ahead of the input amplifier stage resulting in near perfect full scale stability with time and ambient temperature and humidity changes. Also no possibility of zero fold-over errors.

Integration Time

Standard 200 milliseconds signal input integration time.

Sample Rate

Nominally 1.6 to 2.5 readings per second.

Display

Seven segment gas discharge display. The one-half inch high numbers are readable from 30 feet in lighted or daylight conditions. Leading zeros are normally blanked.

Calibration Stability

Stability of $\pm$ 0.01% of reading for 30 days; long term stability of $\pm$ 0.03% of reading for 6 months from last calibration. Temperature effects from 32°F to 122°F are $\pm$ 0.003% of reading °F. Full scale equals 10,000 counts; zero and span temperature stability specifications are based on maximum tare of 10% of full scale with precision wire wound span and coarse tare resistors having a temperature coefficient of 10 ppm/°C or better.

Overload

100 VDC or 115 VAC (RMS) continuous at input with no damage.

Polarity

A "−" is placed in the first blanked digit adjacent to the first displayed number, when the input to the instrument goes negative. Absence of a "−" indicates positive polarity.

Common Mode Noise Rejection

Greater then 120 db at any frequency with 100 ohms unbalance in either HI or LO leads or with BCD outputs connected to earth ground; greater than 140 db at 59Hz increasing at 18 db/octave above 60 Hz. No CMR degradation with grounded BCD outputs.

Normal Mode Noise Rejection

At least 20 db rejection at 10 Hz, increasing by 24 db/octave to over 92 db at 59 Hz. Noise that is superimposed on the signal is attenuated by the three pole active filter, plus the integrator (4 pole equivalent filter).

Transducer Compatibility

Specifically designed for use with any strain gage balanced bridge device, transducers, or load cells with full bridge, 120 to 1000 ohm source resistance, foil or wire elements. Transducer sensitivity of 1 to 4mV/volt is directly compatible.

Bridge Excitation

Internal selection of 5, 10, 15 or 18 VDC. Capable of providing excitation voltage to a maximum of eight 350 ohm bridges simultaneously. Current limiting protects the supply from accidental overload. The following table shows the maximum number of bridges that can be used in parallel.

Bridge Excitation Voltage	5V	10V	15V	18V
Maximum Current Capability	115 ma	230 ma	350 ma	350 ma
Max. No. of 120 Ohm Bridges	3	3	3	3
Max. No. of 350 Ohm Bridges	8	8	8	6

External Excitation

An external power supply can be easily and conveniently substituted for the internal supply. Remote sensing of the bridge voltage allows use of an external supply without sacrificing the true ratiometric measuring technique.

Remote Sensing

Six wire remote sensing eliminates errors due to long lead lengths of transducer cables and its resistance variations with time and temperature.

Remote Sense Impedance

100K ohms or greater; specified performance guaranteed with voltage drop across bridge excitation leads as high as 1.2 volts per lead.

Calibration

Three point calibration; zero, plus full scale, and minus full scale.

1.5 FIELD SELECTABLE FUNCTIONS OPTIONS

1.5.1 Extended Range

Extend range by positioning a Cambion jumper in X1, X2 or X5 position on T2A plug-on board for a maximum reading of 25,000, 50,000 or *(1)25,000 with 1:25000 resolution. When the sixth digit (fixed zero) is used the multiplication factors become respectively X10, X20, or X50. *Leading "1" not displayed over 100,000.

1.5.2 Input Filter Response

Replace filter capacitors (installed on threaded, screw on terminals) for desired filter response.

1.5.3 Bridge Excitation Voltage

By positioning a Cambion jumper, 5, 10, 15 or 18 VDC bridge excitation voltage is available.

1.5.4 Display Hold

Closure of an external switch across pins 20 and 16 on BCD Connector J1 will retain latest reading until the closure is removed.

1.5.5 Positive Tare

Insert fixed resistor across R+TARE threaded screw-on terminals to compensate for "dead load" or positive offsets.

1.5.6 Negative Tare

Insert fixed resistor across R−TARE threaded screw-on terminals to compensate for negative off-set.

1.5.7 Isolated BCD Outputs (Option S6P)

Five decade parallel BCD outputs (8-4-2-1 code), one bit polarity, Sample Command Signal, Overload and Sample Complete Signal. All outputs are buffered and isolated using an optical isolation method.

1.5.8 Analog Outputs (Option 13, 13-1)

There are two different types of outputs available. Option 13 uses a bi-polar DC amplifier and has been designed to operate in applications where source impedance does not exceed 1000 ohms. Option 13-1 uses a chopper amplifier and can operate with source impedances from 0 to 50,000 ohms. Both types provide true, amplified representations of the input signal at Connector J2. See Section 4.2 for further description.

1.6 FACTORY INSTALLED OPTIONS

1.6.1 Remote Programming (Option 15)

Used with Doric Model TSU Transducer Switching Unit for digital identification using BCD code (8-4-2-1) and decimal selection. If multiple TSUs are required, this option allows identification of the specific TSU in use at the output device.

1.6.2 Motion Detector (Option 18)

Designed to limit printout errors due to scale platform oscillations. See Section 4.3 for theory of operation and specifications.

1.6.3 Front Panel Zero (Tare) Control (Option 07)

Potentionmeter with front panel knob provides up to ±3% (±300 counts) zero tare adjustment at 1μV per count sensitivity. Control range varies inversely with sensitivity.

1.6.4 R Cal Test Switch (Option 08)

Instrument calibration can be checked by inserting precision resistor across two threaded screw-on terminals to check calibration. Depressing the factory installed R Cal switch will shunt this resistor across one leg of the bridge giving an instant check of calibration. See Section 5.6 for selecting the value of this resistor.

1.6.5 Internally Mounted Zero (Option 20) or Span (Option 21) Controls

This option provides the capability of mounting the zero or span controls internally. When incorporated, adjustment of these controls will be performed by sliding the instrument from the chassis.

1.6.6 Display Segment Test (Option 28)

A sub-miniature pushbutton switch, mounted on the front panel, when depressed causes the display to show −888888. This tests all used segments of all indicators. This option is quite useful in servicing the instrument since 40% to 50% of the entire digital section of the DS-300-T2 is exercised when the test switch is depressed.

1.7 ACCESSORIES

1.7.1 DORIC MODEL TSU, Transducer Switching Unit

The Model TSU Transducer Switching Unit permits measurement of multiple transducers of different or identical parameters (such as weight, torque, thrust, etc.) from channel to channel, using the same DS-300-T2.

1.7.2 DORIC MODEL DS-305, Digital Control Unit

Used for controlling, batching, blending, filling, with automatic shutoff, and selecting automatic or remote tare settings for weigh scales or different applications. Its applications also include setting limit and overload alarm points and making peak measurements of stall torque, pressure pulses, or material rupture force. See the DS-305 Manual for further information. It is important to note that if your DS-300-T2 is accompanied with a DS-305, disconnecting the DS-305 from the main instrument will render the DS-300-T2 inoperative. A "By-Pass-Connector" must be installed for separate DS-300-T2 operation. See Section 6.4 for "By-Pass-Connector" connections.

1.8 REMOVAL OF INSTRUMENT FROM CHASSIS

The field selectable functions and adjustments are accessible from the interior of the instrument.

By removing two screws, as shown in Figure 1-2, from the rear panel, and removing the line filter screw, the instrument will slide forward allowing access to the interior. The instrument also may remain ON while exposed, but when selecting any function, it should be turned OFF to avoid electrical damage.

It may be necessary to remove an option board to make certain function selections. When removal of such a board is required, it is important that the instrument be turned OFF and also a careful inventory of all screws and washers be kept to avoid losing parts inside the instrument. After the selection has been made, all screws should be returned to their proper location and tightened down.

FIGURE 1-3. PIN CHART FOR EXTERNAL CONNECTORS

CONNECTOR J2

1	+ SENSE	8	GUARD
2	– SENSE	9	ANALOG OUTPUT (HI)
3	+ EXC	10	ANALOG GROUND OR –18VE OR OPEN
4	– EXC AND ANALOG OUTPUT LO	11	NOT USED
5	R CAL	12	NOT USED
6	+ SIGNAL	13	NOT USED
7	– SIGNAL	14	NOT USED

CONNECTOR J9

1	STORE	13	L_R
2	DISPLAY COUNTER RESET	14	L_O
3	UNDER TARE	15	BY-PASS CONNECTOR
4	DIGITAL GROUND	16	DIGITAL GROUND
5	GATED CLOCK	17	DIGITAL GROUND
6	NOT USED	18	NOT USED
7	POLARITY	19	DIGITAL GROUND
8	MASTER CLOCK	20	NOT USED
9	RESET 2	21	SAMPLE COMPLETE
10	$\overline{\text{RESET 3}}$	22	NOT USED
11	DISPLAY COUNTER INPUT	23	NOT USED
12	L_1	24	BY-PASS CONNECTOR

CONNECTOR J1

1	8^2	19	Not Used
2	1^2	20	HOLD
3	2^2	21	SAMPLE COMMAND
4	4^2	22	2^4
5	8^4	23	4^4
6	1^4	24	8^3
7	4^0	25	1^3
8	2^1	26	4^3
9	2^3	27	1^1
10	Not Used	28	8^1
11	$\overline{\text{OVERLOAD}}$	29	8^0
12	$\overline{\text{MINUS SIGN}}$	30	4^1
13	SAMPLE COMPLETE	31	2^0
14	Not Used	32	1^0
15	DIGITAL GROUND	33	Not Used
16	+5 VOLTS	34	Not Used
17	$\overline{\text{MOTION OVERRIDE}}$	35	Not Used
18	$\overline{\text{MOTION}}$	36	Not Used

SECTION 2

INSTALLATION

2.1 UNPACKING INSTRUCTIONS

Because of the rugged construction of the DS-300-T2, little need be done to ensure the instrument has arrived free of shipping damage and no special instructions relative to unpacking need be given.

A cursory visual inspection of the instrument's exterior should be accomplished immediately after unpacking it from its container. If obvious damage is evident, both the shipping agency and Doric Scientific should be notified immediately. If no signs of damage are evident, the instrument may then be hooked up to your particular application. See Section 2.4.

FIGURE 2-1. SHIPPING CONTAINER

2.2 REPACKING; RETURNING THE INSTRUMENT

If it is convenient, the original shipping container should be retained in the event reshipment becomes necessary. If the DS-300-T2 must be returned at any time to Doric Scientific for repair, modification, etc., ensure that the instrument model number, serial number, your name, telephone number and extension and a list of symptoms or work to be accomplished is sent with the instrument. This will aid Doric's Customer Service Department in contacting you if required, and completing the necessary modifications or repairs within a time agreeable both to you and Doric Scientific.

To aid you in repacking the instrument, in the event the original shipping carton has been discarded, this list of instructions is provided.

a. Use a strong, reinforced cardboard carton of sufficient size to allow for ample packing material around all six sides of the instrument.
b. Ensure all option boards are securely fastened down and main instrument assembly if fastened inside the chassis using the two screws on the rear panel.
c. Wrap meter in plastic or strong paper; place it centrally located in the box, ensuring that polyfoam, bubble pack or rubberized hair, etc. surrounds all six sides of the instrument.
d. Use strong tape when securing the flaps of the box and be sure to label box

"FRAGILE DELICATE INSTRUMENT." Send to Doric Scientific, freight prepaid. NEVER USE U. S. MAIL SERVICE. Doric Scientific will return the instrument to you freight prepaid upon completion of desired work.

It is important to pack the instrument well, taking as many precautions as possible, because damage in shipment is possible. You may obtain a shipping carton similar to the original one, free of charge, by contacting Doric Scientific.

2.3 MOUNTING

The DS-300-T2 arrives as a standard, bench type, instrument. Four rubber feet allow the instrument to sit flat, or for ease of viewing, a bail assembly, located on the under side of the instrument, may be pulled down to give an approximate 25 degree viewing angle.

2.3.1 Rack Mounting (Option W4)

When included, this option contains a rack adapter and mounting hardware to convert the standard bench mount instrument to a rack mounted instrument. Either one or two instruments may be mounted in one adapter. If only one instrument is mounted, a filler panel is provided to give a finished appearance to the vacant space. Follow these steps to accomplish rack mounting in a standard 19 inch rack.

a. Remove the four feet and bail assembly.

b. Insert the four screws provided in kit through the bottom of the rack and into holes previously used to secure feet. (Do Not Use The Same Screws Utilized To Secure Feet To Instrument.)

c. Mount filler panel in vacant side by using the four screws also provided in kit.

d. Mount the complete adapter in a standard 19 inch rack using four customer supplied screws.

2.3.2 Panel Mounting (Option W3)

This option enables panel mounting of a single instrument. A panel cut-out diagram, Figure 2-3, should be consulted for information regarding the size of cut-out, screw hole sizes and locations. The following instructions will aid you in panel mounting your instrument.

a. Remove feet and bail assembly from instrument.

b. Cut-out from panel the appropriate size rectangular hole; (3.12 inches x 8.62 inches, tolerances appear on Figure 2-3).

c. Drill four holes in panel; size and locations shown on Figure 2-3. Countersink holes using a .390 x 82° countersink.

d. Secure ears to sides of DS-300-T2 with the four screws provided in kit.

e. Insert instrument from rear of panel so holes in mounting ears align with holes in panel.

FIGURE 2-2. RACK MOUNTING

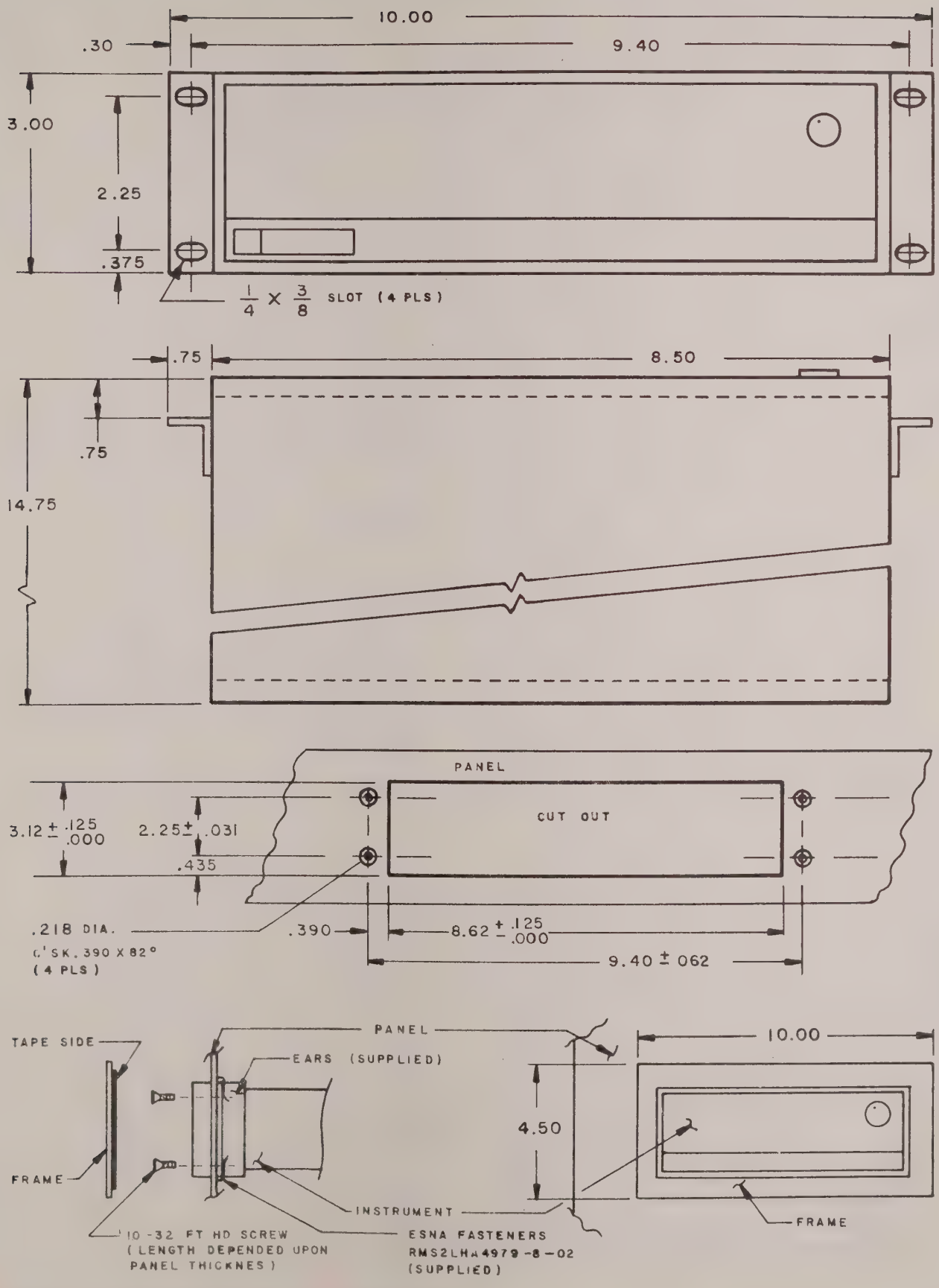


FIGURE 2-3. PANEL MOUNTING CUT-OUT INFORMATION

f. Insert four 10 x 32 screws through panel and into the mounting ears.

g. Peel off paper from decorator frame and put frame around instrument, covering exposed screw heads, and press firmly in place.

2.4 BRIDGE CONFIGURATIONS AND INSTALLATION

2.4.1 Introduction

This section describes the DS-300-T2's hook-up and transducer connections with wiring instructions and recommended customer usage.

It is important to note the following items prior to instrument check out.

a. The DS-300-T2 will not read correctly unless the load cell or simulated full bridge has been properly connected to the instrument. There must also be a resistor in the R Span position on the T2 plug-on board. See Section 5.2 for R Span calculation.

b. Connect the +EXC and + Sense leads together at the bridge terminals. Connect the -EXC and the - Sense leads together at the bridge terminals.

c. For proper operation, the guard should be connected to the -EXC at the bridge or as close to the bridge as possible.

d. If the bridge is to be grounded to earth ground, it must be done at only one point, at the bridge, to avoid ground loop circulating currents.

e. The HI and LO inputs may be shorted together for a quick check to ensure the instrument reads about ± 0000, or if tare has been incorporated, a reading approximately equal to the tare desired.

2.4.2 Installation

The DS-300-T2 will operate with any of the bridge configurations shown in Figures 2-4, 2-5 or 2-6. However, the 7 wire system, when the R Cal option is incorporated, or the 6 wire system, when R Cal option is not incorporated, is recommended because of their stability and accuracy. All performance specifications are based on these configurations.

2.4.3 Full Bridge, Four Wire and Guard Configuration

This configuration is satisfactory if cable length is not extremely long and if the system is operated under stable temperature environments and extreme accuracy is not a requirement. (See Figure 2-4.)

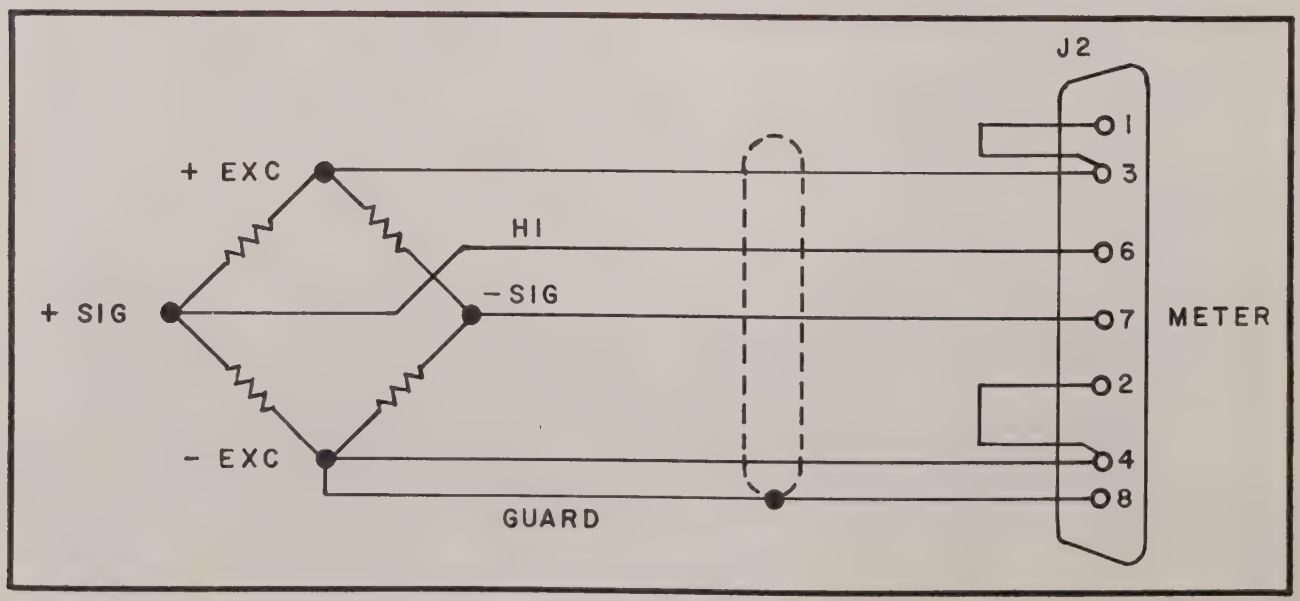


FIGURE 2-4. FULL BRIDGE 4 WIRE AND GUARD CONFIGURATION

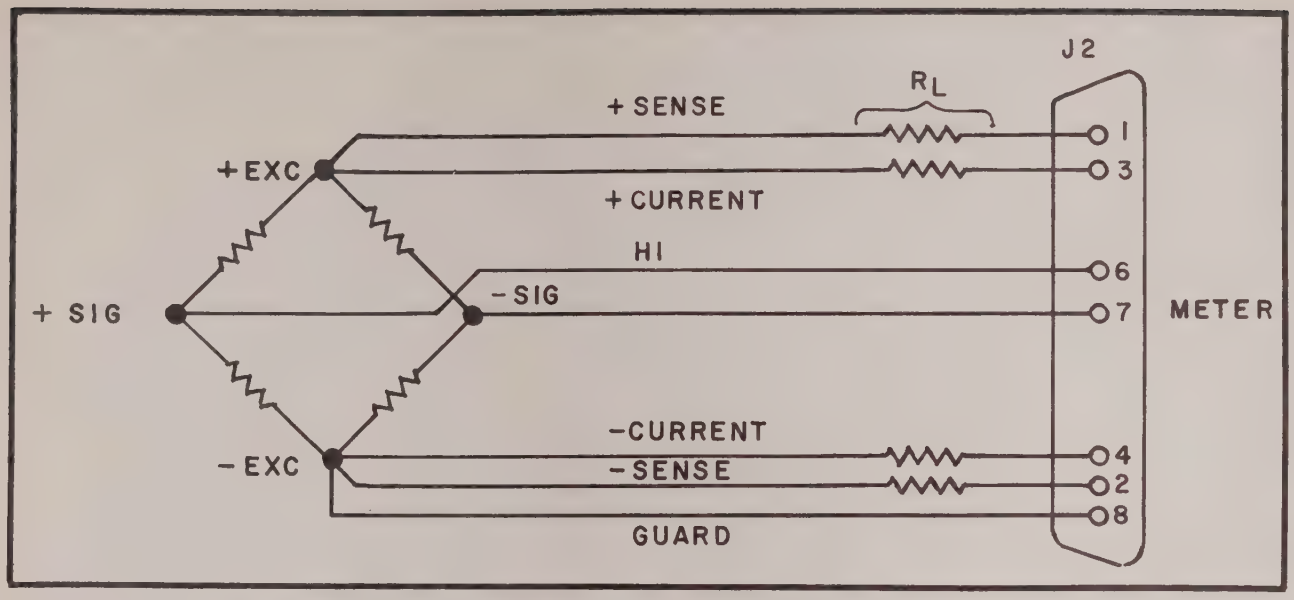


FIGURE 2-5. FULL BRIDGE 6 WIRE AND GUARD CONFIGURATION

2.4.4 Full Bridge, Six Wire and Guard Configuration

The wiring diagram in Figure 2-5 differs from that of the four wire system in that it has an extra pair of non-current carrying remote sense leads. The design of the DS-300-T2's excitation power supply allows two very distinct advantages when the two remote sense leads are used. First, the desired excitation voltage is available at the bridge terminals regardless of cable length. Second, the instrument is supplied, through the sense lines, with the true excitation voltage appearing at the bridge. Because the instrument is a ratio measuring device, reading in MV/V, both the bridge output (MV) and the excitation supply (V) must be precisely measured at the power supply end of the cable. With long cables, consequently, the lead resistance can cause a large voltage drop to occur. This voltage drop will cause the instrument to sense a larger excitation voltage than actually exists at the bridge. This not only may change the calibration of the DS-300-T2, but also all calculations for R Span and R Tare may no longer be valid. Furthermore, if the cable resistance changes because of variations in temperature or if the current varies, due to changes in bridge resistance, a change in excitation voltage at the bridge will also occur. The instrument in the 4-wire system has no way of sensing this and incorrect data may result. The remote sense leads eliminate this problem by carrying the bridge voltage to the instrument without introducing any error due to currents or changes in input impedance.

2.4.5 Full Bridge, Seven Wire and Guard Configuration

For ultimate accuracy, stability and overall performance when R Cal is used, it is recommended that the 7-wire system, shown in Figure 2-6, be used.

This configuration is identical to the 6-wire system, with one exception. A seventh wire has been added to carry the calibration currents to the bridge when R Cal is used. This is accomplished for the same reason the plus and minus sense leads are used. If the R Cal current is carried in the LO lead, a voltage drop in the LO lead will appear in series with the calibration voltage across the bridge. The equivalent calibration voltage created by R Cal then becomes a function of the LO lead resistance. This effect can be eliminated by supplying the current to the bridge through a separate (R Cal) wire and using the LO lead as a non-current carrying sensing lead for the bridge output. It should be noted that this effect only affects the reading obtained when

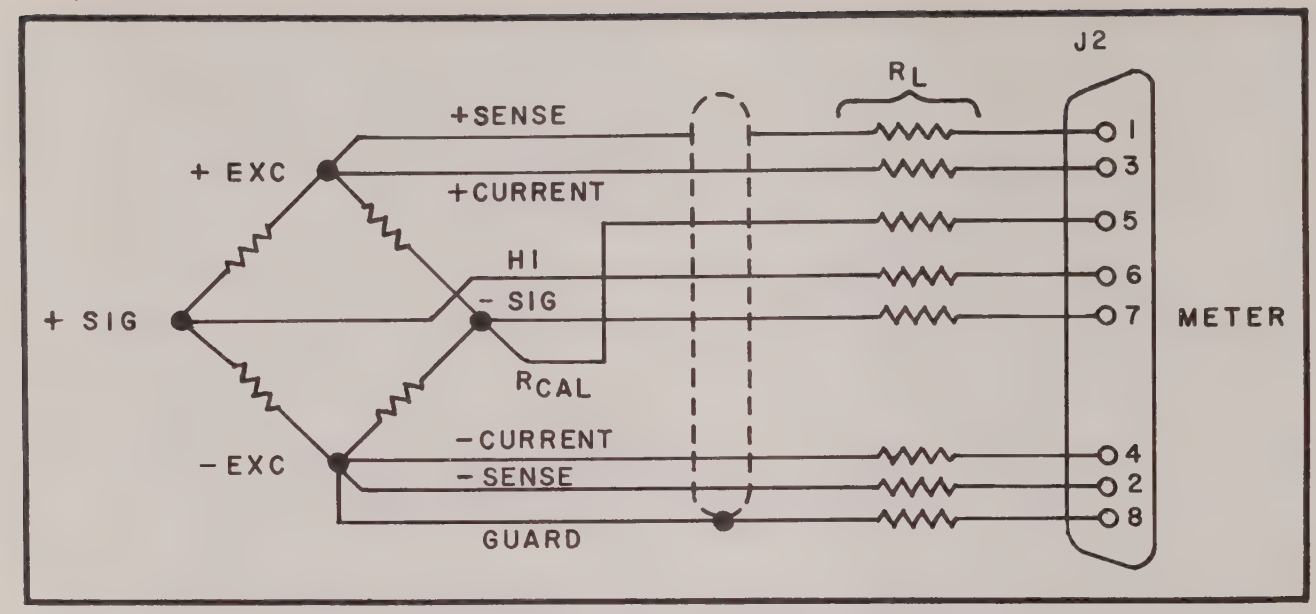


FIGURE 2-6. FULL BRIDGE 7 WIRE AND GUARD CONFIGURATION

the R Cal pushbutton is depressed. First, if the R Cal reading is to be interchangeable from the lab condition to the on-site condition, the 7-wire system must be used. Second, with long cable runs or severe temperature variations, apparent changes in the R Cal readings of up to 1% can be encountered if the 4 or 6-wire system is used when the R Cal option is incorporated.

NOTE: An 8th wire may also be used with R Cal to prevent calibration currents from flowing through remote sense leads. The voltage drop produced by R Cal current through the -SENSE lead is a much smaller percentage of the excitation power supply, but the magnitude of the voltage drop appearing in series with the low level signal can introduce an appreciable error. The 8th wire is, therefore, not as necessary as the need for the 7th wire.

2.4.6 Connections for Minimizing Common Mode Noise

Guarding must be used whenever low level measurements are to be made where a significant amount of AC or DC common mode voltage, (E_{CM}), exists between the DS-300-T2 chassis ground and the -EXC terminal of the transducer. See Figure 2-7. In an unguarded system where such a condition exists, the common mode current flows from the transducer LO lead, through the isolation impedance of the DS-300-T2 (between LO and chassis ground), to local ground causing a voltage drop in the LO lead. This voltage drop appears as normal mode voltage in series with, and as part of, the source signal being measured and could produce significant errors or noise in the displayed readout of the DS-300-T2. To avoid this, a suitable guarding system must be used based upon the characteristics of the transducer being used.

Some transducers must be grounded at the installation site for safety or mechanical reasons, (e.g. strain gages bonded to a missile airframe). For this application, connection "C_1" should be made as shown in Figure 2-7. In this guarding method the common mode currents are carried from remote ground through connection "C_1" and guard to drive the shield surrounding the measurement section of the DS-300-T2 to a potential almost equal to that of E_{CM}. The voltage drop across "Z1" is small due to no current flowing through the LO lead of the DS-300-T2. It is important to make

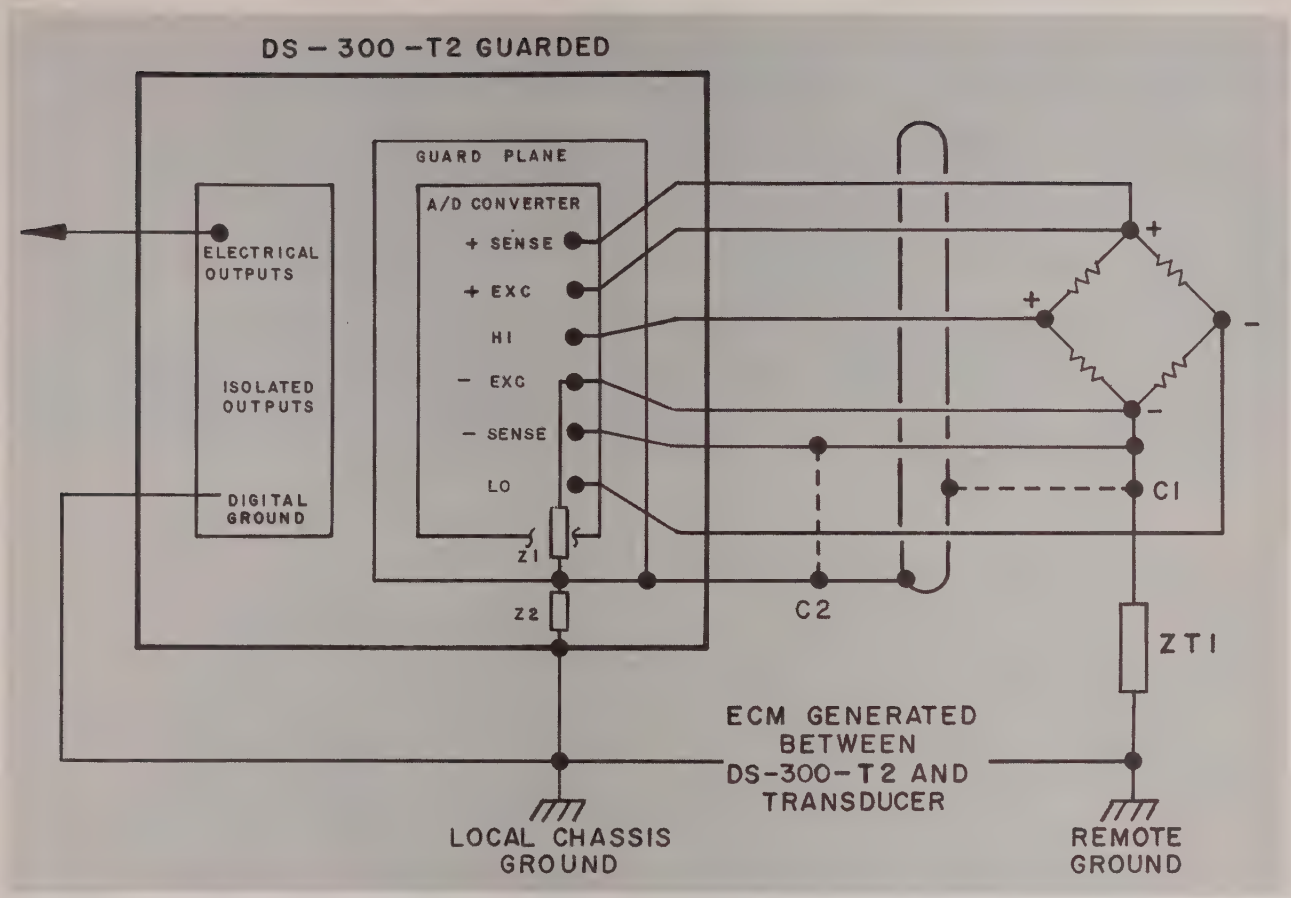


FIGURE 2-7. CONNECTIONS FOR MINIMIZING COMMON MODE VOLTAGE

this connection at the remote site, so that guard is at the remote ground potential most closely associated with the transducer being measured. For the grounded transducer "ZT1" is zero.

For truly floating transducers the transducer isolation impedance, "ZT1" is very high. In this application, connection "C_2" should be made at local -EXC. This simplifies scanning systems by requiring only signal HI and LO lines to be switched rather than HI, LO and Guard. For a superior guarded system we recommend connection "C_1" be made and utilized whenever possible.

In some floating transducer applications an extra wire may be connected from local chassis ground to the -EXC terminal of the remote transducer, which significantly reduces the voltage appearing between the bridge and the DS-300-T2. This will result in a large increase in the effective common mode rejection. Generally, the quasi-floating transducers work best with connection "C_1." It should be remembered that IN ALL CASES THE TRANSDUCER OR METER MUST BE GROUNDED SOMEWHERE, BUT ONLY AT ONE POINT. A completely floating transducer-meter will allow uncontrolled common mode voltage to develop which is potentially dangerous and will adversely affect the accuracy of the DS-300-T2.

2.5 POWER REQUIREMENTS

The DS-300-T2 is designed to operate from either a 115 ± 10 VAC or 230 ± 20 VAC, 50 - 400 Hz power supply. A switch on the rear panel controls the operating voltage.

A 0.50 amp Slo Blo power fuse is used for 115 V operation; a 0.25 amp Slo Blo power fuse is used for 230 V operation.

It should be noted that the third prong (chassis ground) of the AC connector on the rear panel

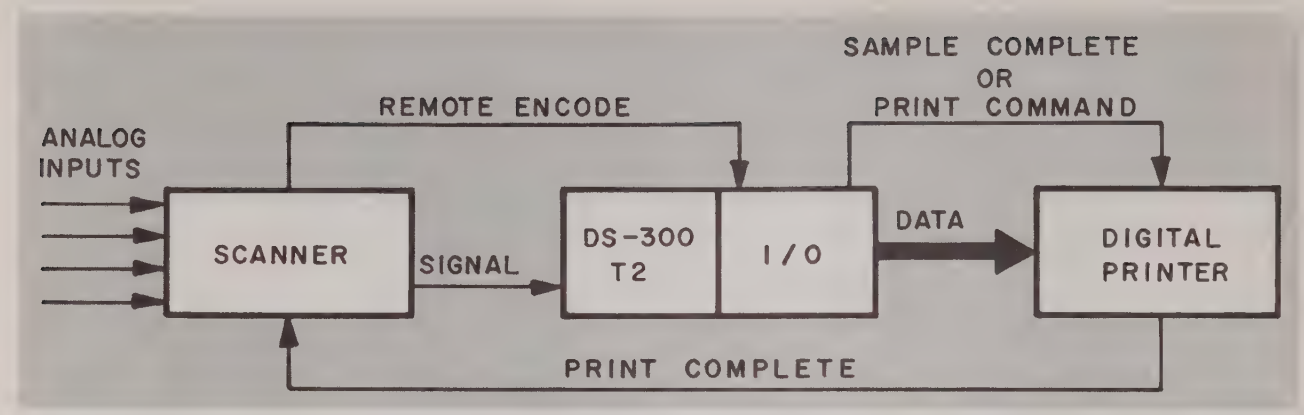


FIGURE 2-8. TYPICAL SYSTEM INTERFACE

should be connected to earth ground for reliable operation.

The excitation supply is completely floating with respect to the DS-300-T2 main operating supplies, therefore, the -EXC terminal may be earth grounded at the bridge if desired.

NOTE: The DS-300-T2 must be hooked up to a strain gage transducer for proper readings. An open input (or even a shorted input with no load cell connection) will result in erroneous readings.

2.6 TURN-ON

Prior to applying power, ensure the proper excitation supply voltage has been selected. The standard DS-300-T2 has four possible excitation supplies available to excite the transducer bridge: 5V, 10V, 15V and 20V. The instrument is normally shipped with the 10V excitation supply selected unless otherwise specified at time of purchase. To change the excitation supply to 5V, 15V or 20V, move the Cambion jumper to the excitation supply desired. See Figure 2-10.

It is important that the correct excitation supply be chosen prior to turn-on to assure the bridge will not be overloaded. However, it is recommended that the transducer manufacturer's maximum specifications be observed.

Finally, the proper R Span resistor should be installed across the provided R Span terminals. (See Figure 2-10 for location.) For R Span calculations, see Section 5-2 .

2.7 SYSTEM INSTALLATIONS

2.7.1 Digital Output Device

A typical closed loop system is shown in Figure 2-8. A print complete signal from the printer causes the scanner to select a new channel. A remote encode (sample command) pulse from the scanner causes the DS-300-T2 to accept the signal input from a new channel and new encoding will begin. A sample complete pulse (print command) is taken from Connector J1 of the DS-300-T2 and fed to the printer, where it will enable the printer. The entire procedure is then repeated.

One problem exists when the DS-300-T2 is used in the scanning application. During the initial encoding of a channel's analog signal, the DS-300-T2's filter is settling. This introduces an error at the output. If two or more readings are to be taken from one channel prior to printing or switching, the second and subsequent readings will be correct as the input filter will have settled. However, when the scanner switches channels, the first encoding of the new input will again introduce an error. In cases where a filter has a very low corner frequency the first few encodings will be in error.

To eliminate this error, an external time delay must be introduced to delay the remote encode pulse. This is accomplished by breaking the remote encode line and wiring in a delay of 800 milliseconds or more with a low frequency filter. See Figure 2-9. The result being, the remote encode pulse

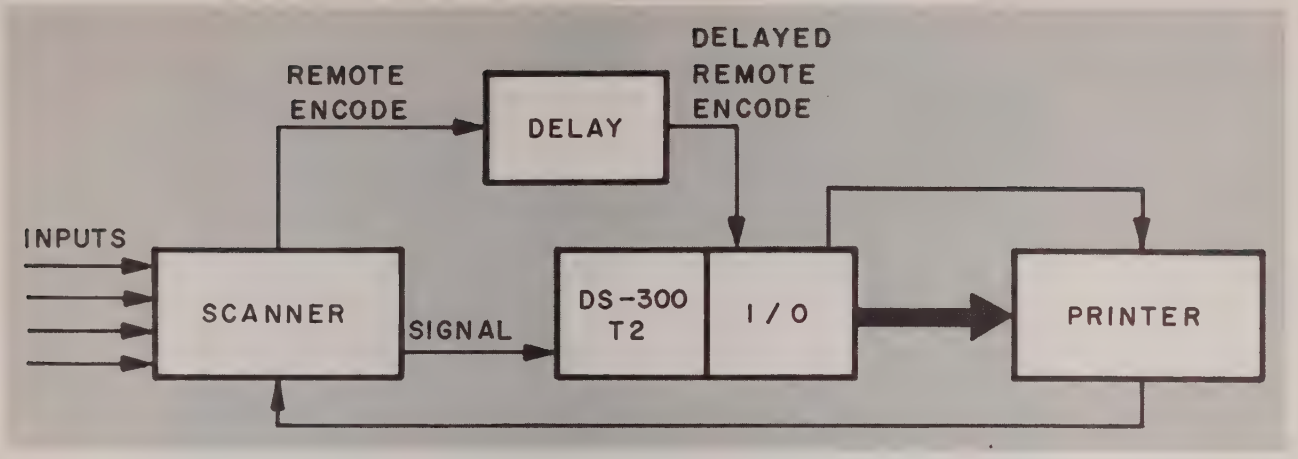


FIGURE 2-9. SYSTEM INTERFACE WITH DELAY ADDED

will be delayed for 800 milliseconds allowing the filter to settle from the previous sample complete signal and ensuring proper auto-zero time. This, in turn, will ensure correct readings with every first encoding of each channel being selected.

The delay of 800 milliseconds is valid only for filters with a cut-off frequency of 4Hz. For filters with lower cut-off frequencies, the delay is equal to the settling time of the filter plus 200 milliseconds.

The DS-300-T2, when equipped with I/O card (Option S6P) will meet the stated common mode rejection ratio specifications for up to 250V p-p (± 125 volts) common mode voltage. Overvoltage protection is provided up to 330 volts p-p. To ensure that the common mode voltage is within the specified limits, digital ground may be returned to chassis ground when the I/O Connector J1 is used. This return path may be connected to the ground terminal of the output device. The signal source returns to chassis ground either directly or through the source of the common mode voltage. The pins used on Connector J1 are listed in Figure 1-3.

2.7.2 External Excitation Supply

It is possible to disconnect the internal excitation supply to facilitate the use of an external excitation supply without any major modifications to the DS-300-T2. To allow usage of an external excitation supply, perform the following steps.

a. Connect the plus and minus EXC leads from the external excitation supply to the load cell, leaving pins 4 (-EXC) and 3 (+EXC) open at Connector J2.
b. Connect the ± Sense leads from the load cell to the DS-300-T2 (Connector J2, pin 1 (+Sense), pin 2 (-Sense).
c. Remove or cut jumpers J+ and J- on the T2 plug-on board. See Figure 2-10 for jumper locations.

2.7.3 Instrument Removal from Chassis

To facilitate selection of certain functions it will become necessary to remove the main instrument from its chassis. This can be done by removing the two screws located on the rear panel and the RF line filter screw and sliding the main instrument forward. If removal of an option board is necessary, it is important to ensure all screws and washers can be accounted for prior to instrument turn-on. Care must also be taken when mating Elco pins. See Figure 1-2 for rear panel view and screw locations.

2.8 FIELD INSTALLABLE OPTIONS

2.8.1 Isolated BCD Outputs (Option S6P)

Isolated BCD outputs is a field installable option. It provides five decades of parallel BCD (8-4-2-1 code) plus a single polarity bit at Connector J1 for external use with printers, computers, data acquisition systems, etc. When this option is in-

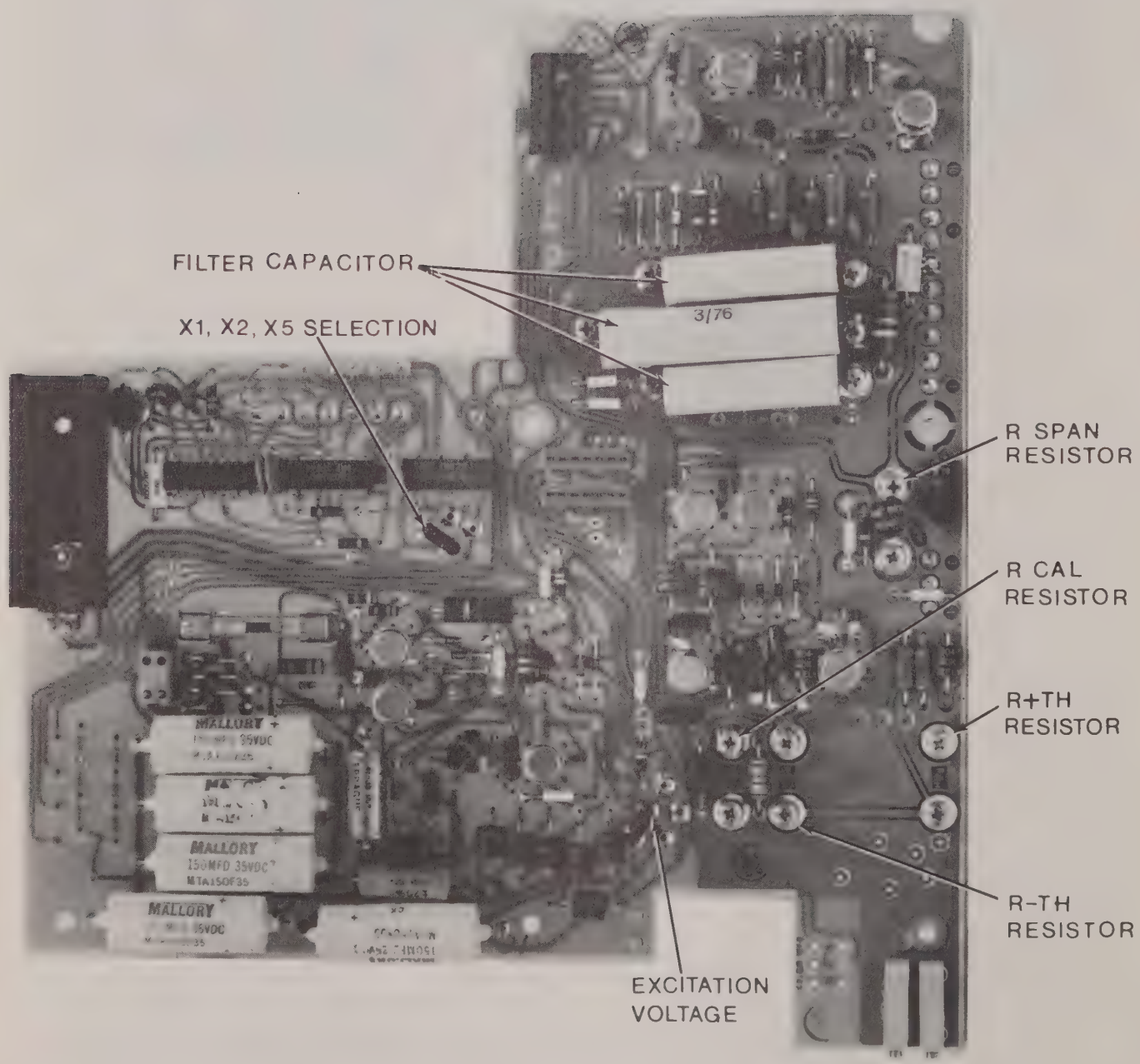


FIGURE 2-10. DS-300-T2 PLUG-ON BOARD

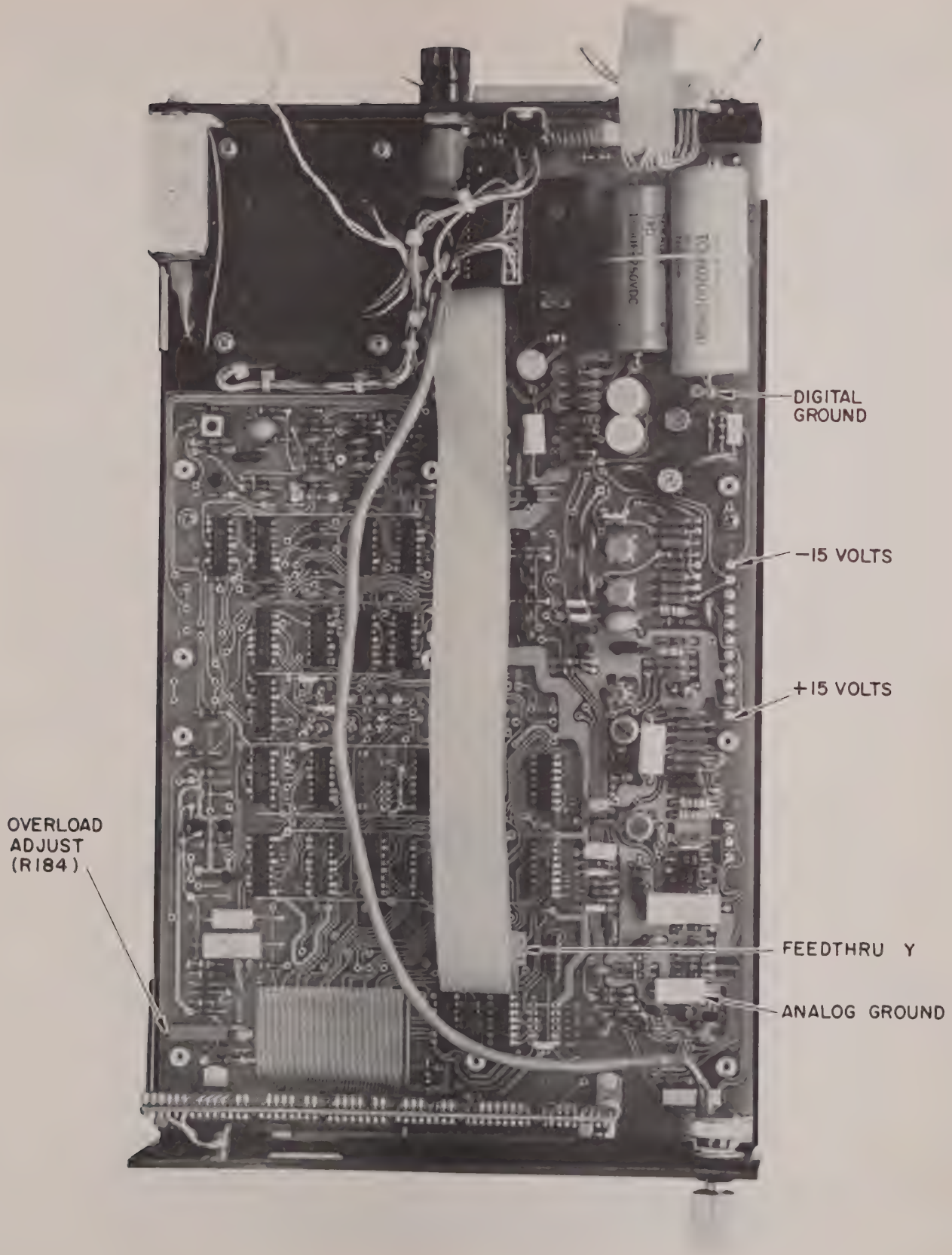


FIGURE 2-11. DS-300-T2 MOTHER BOARD

stalled, remote programming of sample command is also available. A sample complete signal is also provided at Connector J1 for use as a print command signal. See Figure 1-3 for pin information.

The BCD digital outputs are all isolated and buffered using an optical coupler method. Since they are isolated, they may be grounded at the output with no loss of isolation or sacrifice in noise rejection characteristics. The BCD digital code at the output is positive true logic, (unless otherwise stated; negative true logic is available upon request), and is compatible with DTL, TTL and SUHL logic systems.

Installation of this option entails cutting seven jumpers on the T2 Mother Board and plugging-on the I/O board using 14 Elco pins. The DS-300-T2 is completely tested at the factory to ensure acceptance of this option. No field testing need be done. See Figure 2-11 for location of the seven jumpers and Elco pins.

To give the instrument a remote sample command, two things must be accomplished. First, the HOLD LINE (pin 20), Connector J1, must be tied to the +5V line (pin 16) of Connector J1. Then a positive-going edge of approximately 4V amplitude, 1 microsecond minimum rise time, 50 microseconds minimum duration, must be applied to pin 21. See Figure 2-12 for timing diagram.

The BCD outputs come from a series of inverters and have an output swing of 0 to 5V and an output impedance of 2K ohms.

The sample complete pulse goes to a +5V level at the end of an encoding, at which time BCD numeric outputs and polarity information are stable at Connector J1 and ready to be read or printed. The pulse will return to zero at the start of a new encoding and the cycle will then begin again. The output impedance of the sample complete signal is also 2K ohms.

NOTE: If, after installed, the I/O board is removed for any reason, the instrument will not function properly. To allow the instrument to operate without the I/O board, jumper the seven points shown in Figure 2-11. These are the same jumpers that must be cut if the I/O board is installed in the field.

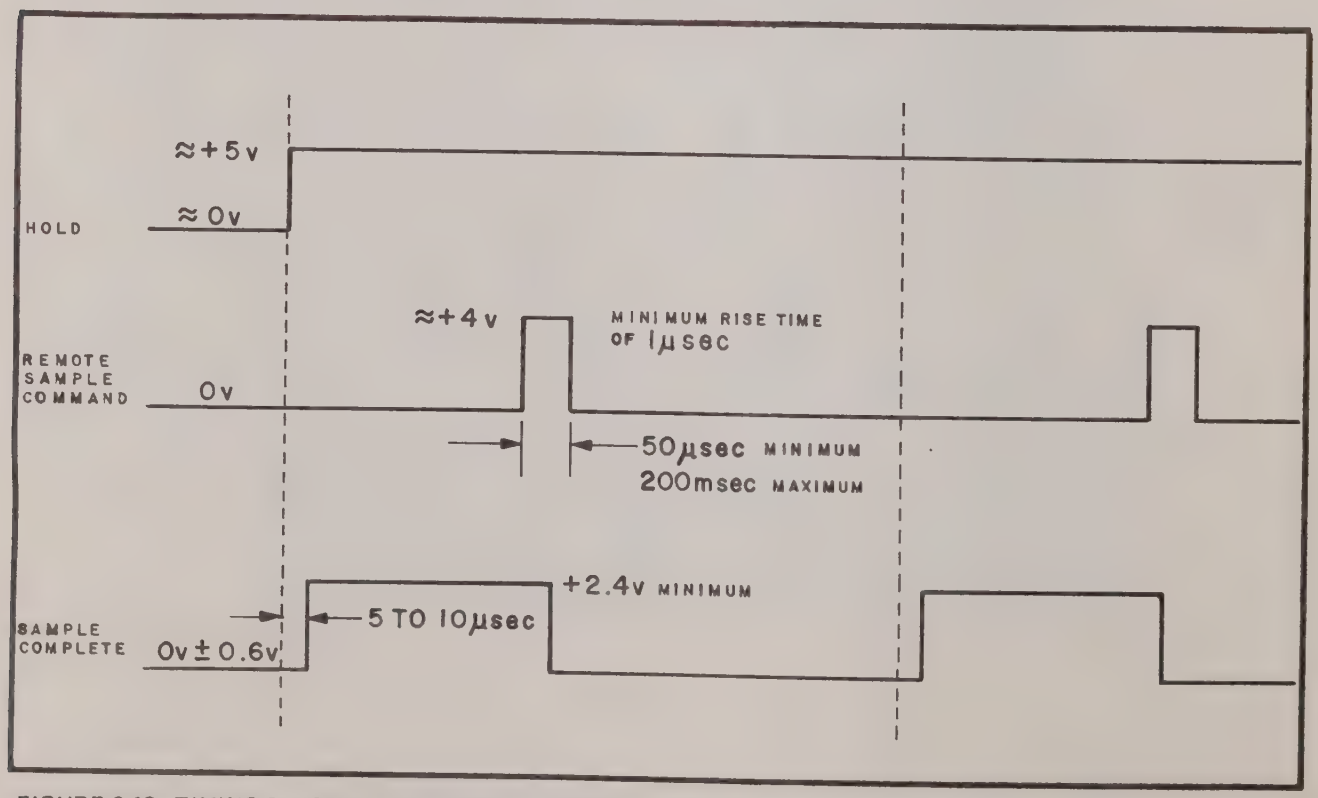


FIGURE 2-12. TIMING DIAGRAM FOR REMOTE SAMPLE COMMAND

2.8.2 Analog Output (Option 13, 13-1)

This option can be either factory installed or installed in the field. If it has been factory installed, refer to Section 4.2 for the calibration procedure. If it is to be field installed, this section is provided to aid you in successfully installing it. Perform the following steps for field installation.

Step 1

a. Remove the DS-300-T2 from the chassis.

b. Connect the 16 pin connector from the option board to the socket provided on the T2 plug-on board.

c. Install the option board as shown in Figure 2-13 using the screws and washers provided in the kit.

Step 2

a. Remove the jumper located between TP1 and TP2 on the option board.

b. Connect a jumper from the junction of R1 and F1 to signal ground (TP 5).

c. Connect a digital voltmeter across R2.

d. Turn the DS-300-T2 ON and adjust R16 for a reading of 0 volts ± 5 millivolts.

e. Turn the DS-300-T2 OFF, remove all jumpers and test leads and reinstall the jumper from TP1 to TP2.

Step 3

a. Remove the connector from the socket on the board and ensure it does not lay directly on any circuitry.

b. Attach Connector J2 to the DS-300-T2 and make all connections to the load cell per Section 2.

c. Apply an input to the DS-300-T2.

d. Turn the DS-300-T2 ON and record its readout.

e. Turn the DS-300-T2 OFF and reconnect the connector to the socket on the T2 plug-on board.

f. Turn the DS-300-T2 ON and with the same input applied adjust R23 until the readout equals the recorded value.

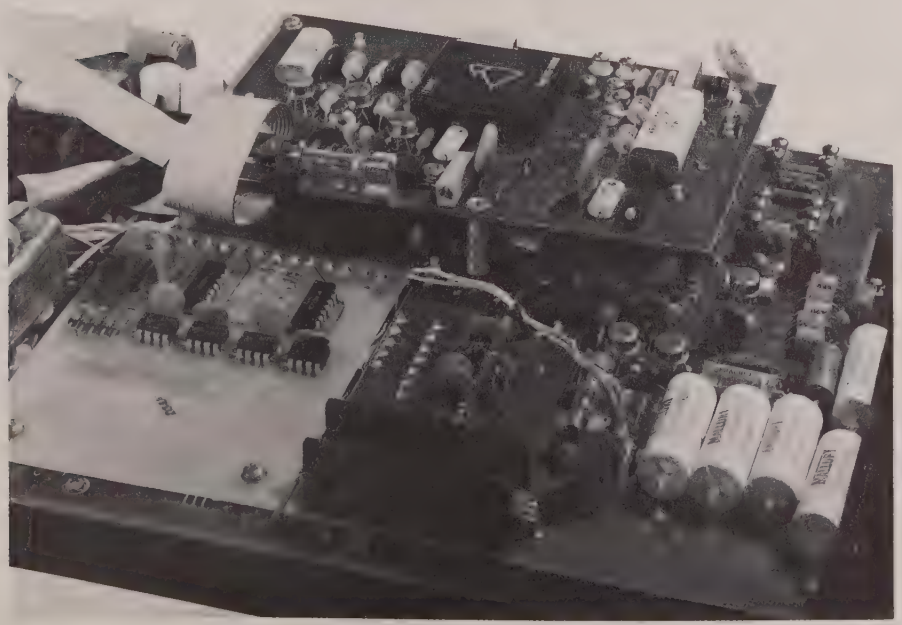


FIGURE 2-13. ANALOG OUTPUT OPTION BOARD INSTALLED

g. Turn the DS-300-T2 OFF.

Step 4

a. Jumper the junction of R1 and F1 to signal ground (TP5).
b. Connect a jumper across R37.
c. Connect the digital voltmeter across TP 5 and TP 6.
d. Apply the required input to the DS-300-T2 for a reading of ± 0000 on the DS-300-T2.
e. Turn the DS-300-T2 ON and adjust R7 for a reading of 0 volts ± 10 millivolts on the voltmeter.
f. Turn the DS-300-T2 OFF and connect the voltmeter across TP 3 and TP 4.
g. Turn the DS-300-T2 ON and adjust R30 for a reading of 0 volts ± 1 millivolt on the voltmeter.
h. Turn the DS-300-T2 OFF and remove the added jumper and test leads. Ensure the jumper between J1 and J2 is installed.

After you have finished, refer to Section 4.2 for information regarding calibration of zero (tare) and gain (span).

2.9 FIELD SELECTABLE FUNCTIONS

2.9.1 Display Hold

To put the DS-300-T2 in a hold condition, connect an external switch across pins 16 and 20 of Connector J1; closure of this switch will retain the latest display until the closure is removed.

2.9.2 Coarse Span Resistor

Coarse span can be set by inserting the appropriate R Span resistor across the threaded screw-on terminals located on the T2 plug-on board. See Section 5.2 for R Span resistor computation and installation.

2.9.3 Coarse Zero (+TARE) Resistor

By inserting a selected precision resistor across the threaded screw-on terminals provided for the R +TARE resistor on the T2 plug-on board, a fixed offset, to compensate for "dead lead" or positive offsets, (+TARE of up to 100% of full scale) is available. See Section 5.3 for R +TARE resistor computation and installation.

2.9.4 Coarse Zero (-TARE) Resistor

Installation of a R-TARE resistor across the threaded screw-on terminals will provide a fixed negative offset (−TARE) of up to 100% of the full scale reading. See Section 5.3 for R-TARE resistor computation and installation.

2.9.5 Calibration Check Resistor

If the R Cal test switch option has been incorporated in the DS-300-T2, inserting a fixed, precision resistor across the threaded screw-on terminals on the T2 plug-on board will allow the R Cal resistor to be switched in parallel with one leg of the bridge. This provides an instant check of instrument calibration when the R Cal switch is depressed. The R Cal switch is not field installable. To remotely activate the R Cal switch, the R Cal resistor may be switched externally between pins 1 and 2 of Connector J2. See Section 5.6 for R Cal computation.

2.9.6 Bridge Excitation Voltage

Selection of a specific bridge excitation voltage should be performed by moving the Cambion jumper for either 5, 10, 15 or 18 VDC on the T2 plug-on board. See Figure 2-10

2.9.7 Extended Range

To extend the range of the DS-300-T2 simply position the Cambion jumper to either the X2 or X5 position. Maximum full scale readings are given in Section 1.5.2. See Figure 2-10 for location of jumper.

2.9.8 Changing the Filter Response

The input filter noise rejection and response can be changed by replacing the filter capacitors C8, C12 and C16 located on the T2 plug-on board. The standard instrument's filter response is nominally set for 4Hz (9 db rejection or 3 db rejection at 2 Hz).

The filter response may be changed by removing the three capacitors from the threaded screw-on terminals located on the T2 plug-on board and replacing them with capacitors suitable for a given application. To calculate the value of these capacitors, perform the following steps.

a. Determine the pole frequency desired,using the known settling time and rejection characteristics. See Figures 7-2, 7-3, 7-4.
b. Find the pole frequency desired on the chart in Figure 7--5 and note the values of C8, C12, and C16.
c. Install these capacitors in their appropriate threaded screw-on terminals. See Figure 2-10 and Drawing 300-4390.

When changing the values of the filter capacitors, certain precautions must be taken as follows:

a. Observe polarity of connections.
b. Use at least 20V rated capacitors.
c. Use dry tantalum capacitors or high grade electrolytics. (Sprague 196D or equivalent for high frequency filters.)
d. Recalibrate instrument.

It is important to note when using tantalum or electrolytic capacitors the settling time could be from 5 to 15 times longer than theoretically calculated due to dielectric absorption of the capacitors. Also, the electrical noise generated due to leakage current variations may not permit the meter to operate satisfactorily below 2 microvolts per digit.

2.9.9 Changing The Display Blanking Point

A line of dashes (-) is shown on the display when gross weight exceeds a preset limit between 100% and 105% of capacity. The limit can be set at the factory or in the field by adjustment of R184 (see Drawing 300-4730-XX for location). A clockwise adjustment of R184 reduces the setting. The adjustment range is from 2,000 to 20,000 active counts on a count-by-one setting.

If the DS-300-T2 is operating with a DS-305-02-H44, the limit applies to gross weight.

2.9.10 Zero Gap Adjustment

Zero gap is defines as the input signal change, expressed in active readout counts, required to cause the DS-300-T2 readout to change from its -1 to -0 transition to its $+1$ to $+0$ and from -5 to -0 to $+5$ to $+0$ respectively. A minus sign is not displayed on the readout with zero indication.

The DS-300-T2 zero gap may be adjusted over the nominal range of 0.7 to 2.0 active counts, and is factory preset to 1.0 ± 0.2 counts. If the instrument functions satisfactorily at the preset zero gap, do not alter the pot setting. Field adjustment of this control is not typically required except in sealed scale applications operating at sensitivities better than $2.5\mu V$/count.

Many internal and external factors affect the settability of zero gap at high sensitivity, including system and instrument random noise, platform vibrations, minute temperature changes, and the operator's subjective judgment. The adjustment procedure is based on a trial and error approach. First, measure the zero gap by gradually increasing the signal into the DS-300-T2 from a slightly negative reading to a slightly positive reading, noting the signal inputs corresponding to the readout transition from -1 to -0 and $+1$ to $+0$. Express this difference, move R88 clockwise; and, to increase move R88 counter-clockwise and retest. Continue this procedure until the desired zero gap is attained. R88 is located on the T2 Plug-On Board, near the heatsink.

SECTION 3

THEORY OF OPERATION

3.1 INTRODUCTION

During encoding the analog input of the DS-300-T2 is connected to the signal input voltage for a period of 200 msec (see Figure 3-1). During this fixed time (t_1), the integrating capacitor C10 charges at a rate proportional to the input signal (E_X). At the end of this fixed integration time, the input of the DS-300-T2 is automatically disconnected from the signal source and connected to a precision reference voltage. This causes the integrating capacitor to discharge toward ground at a fixed rate. The discharge time (t_2) required to reach ground is directly proportional to both the reference voltage and the voltage peak (E_p) reached by C10 during the fixed integration time (t_1). Figure 3-1 shows that t_2 time is directly proportional to E_X and independent of variable factors such as the RC constant, clock frequency, offsets and amplifier gains.

To display E_X digitally, a constant 40 KHz is fed into the display counter during t_1 time. During t_2 time, a selected frequency (dependent upon which extended range function is in operation) is fed to the counter for a time proportional to the input voltage. The clock pulses are sent to the display counter until the time proportional to the E_X input has elapsed. The number in the display counter appears in the readout.

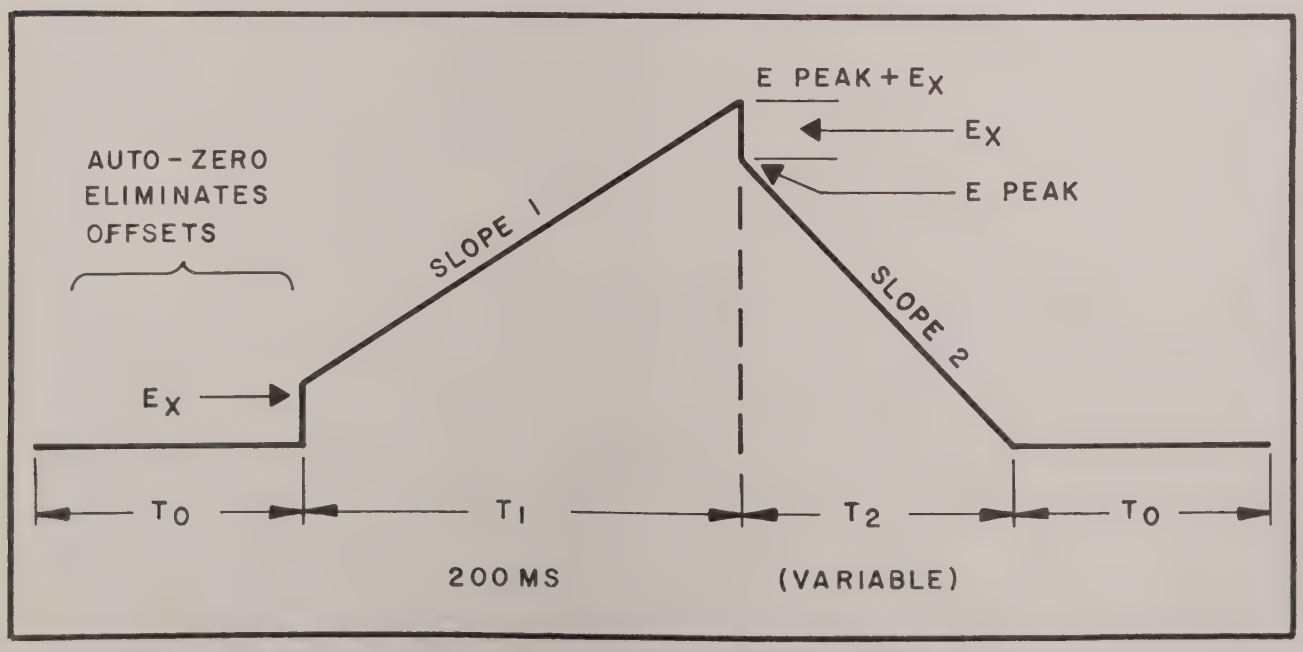


FIGURE 3-1. DUAL SLOPE TECHNIQUE

3.2 MEASUREMENT CYCLE

When the measurement cycle begins (see Figure 3-2) Q2 opens and Q1 closes applying E_X to the integrator A1. At the time Q1 closes, a counter starts to count up from zero to 8000, providing the fixed time base t_1. When the 8000 count is reached, Q1 opens and either Q13 or Q14 is closed to provide the minus or plus reference (E_R), as required, to enable the output of A1 to slew towards ground. At the same time Q13 or Q14 closes, the counter is reset and again counts up from zero. When the charge on C10 is reduced to zero volts, the counting is stopped and the number accumulated in the counter is displayed on the readout.

3.3 AUTO-ZERO

To eliminate zero drift with time and minimize zero drift due to ambient temperature variations, Doric has incorporated its revolutionary AUTO-ZERO circuitry. Refer to Figure 3-2. Between encodings, the instrument automatically disconnects itself from the signal source input and Q2 closes. When Q2 closes the input to the DS-300-T2 is connected to ground. Since the integrator and the zero crossing amplifier are in series, any offsets occurring in the integrator are amplified and fed to the AUTO-ZERO circuit. The amplified sum of any offsets and slow drifts (E_s) is compared with reference to ground by AUTO-ZERO and fed back to the integrator as correction voltage (E_C) to force E_s to zero volts. As long as this operation continues, the output cannot drift off zero.

3.4 STRAIN GAGE BRIDGE OPERATION

Strain gage bridge transducers consist of four resistive, strain sensitive elements connected in a wheatstone bridge configuration. The bridge is usually bonded to a mechanical force-summing structure. The elements are arranged so the resistance in the opposite legs of the bridge increases (or decreases) as the physical load is applied, thus changing the output voltage of the bridge in proportion to the applied load.

3.5 CIRCUIT DESCRIPTION

3.5.1 Power Supplies

The DS-300-T2 uses a multi-shield transformer to minimize the 60 Hz leakage currents flowing through any arm of the load cell bridge.

The 190 volt supply is a half-wave rectified,

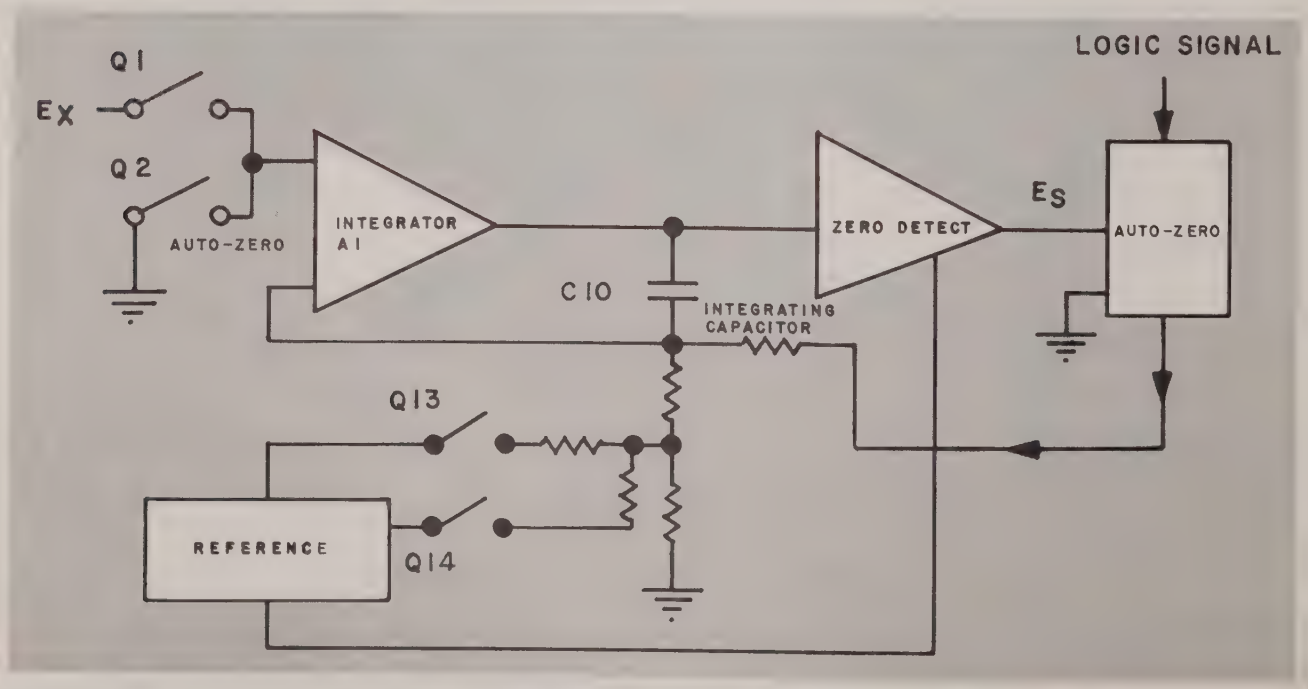


FIGURE 3-2. ANALOG CIRCUITS SHOWING AUTO-ZERO

unregulated supply which is used to drive the digital display.

The +5 volt supply utilizes a full bridge rectifier and a capacitor input filter to provide a well regulated + 5V to the DTL and TTL integrated circuits which are extensively used in the DS-300-T2.

The ± 15 volt supplies are derived from the ± 22 volt unregulated supplies. They are well regulated and are used in the analog circuitry on T2 Mother Board and on the T2 plug-on board. The ± 15 volt supplies are both independent of the digital supplies, which enable earth grounding of the digital supplies in system applications using grounded equipment (e.g. scanners, printers, etc.).

The + 15 volts is series regulated and current limited. The – 15 volts is derived from the + 15 volts by use of an inverting amplifier.

3.5.2 Analog Switching

There are six analog switching channels in the DS-300-T2, all essentially the same. Each channel is formed by a high level driver and junction FET switch. The drivers convert IC logic levels to high voltage swings; then the FET switches convert these voltage swings to solid state "closures." When the driver is turned off, the FET gate becomes zero biased with respect to the source causing a low impedance (<200 ohms) to appear between drain and source. When the driver is turned on, the gate is pulled negative causing a large impedance (>100 megohms) to appear between source and drain.

3.5.3 Sample Rate Generator

The sample rate generator (SRG) is effectively a free running multi-vibrator consisting of a control transistor switch, trigger circuit, active integrator and an RC timing latch that commands the L_1 flip-flop to start each new encoding. The SRG is controlled by L_0. As L_0 goes low at the end of an encoding, Q21 is turned off, causing the integrator (C21) to charge positive at a rate of approximately 7 volts/second. This ramp is coupled with the clock sync and fed to the emitter of Q22. The base of Q22 is biased at + 2.5 V by Z24(5). As the emitter of Q22 approaches + 3 volts, a positive going clock pulse will trigger Q22 on, causing Q23 to turn on, clamping the input of Z24(5) to ground. The inverted output of Z24(6) will set L_1 positive and start a new encoding. The positive level of L_1 will set L_0 positive which turns Q21 on, discharging C21 and resetting the latch formed by Q22 and Q23. In the hold condition, Q21 remains on, inhibiting the integration of C21.

3.5.4 Integrating Amplifier

The integrating amplifier is a high impedance, high gain operational amplifier used as a potentiometric integrator. Its first differential stage is a dual N-channel FET amplifier that has a very high input impedance, extremely low current offset, low input current and low electrical noise. It acts as a source follower and also sets the operating conditions for the second differential pair, which consist of a low noise, high gain, dual NPN transistor. The second stage has a typical gain of 150 and uses local feedback to stabilize the gain.

The third stage is driven by the dual NPN transistor and has a typical gain of 10. Its output drives the input of an operational amplifier Z40 which has a typical loop gain of 80,000. The amplifier is frequency-compensated to avoid any oscillations.

Capacitor C10 is the integrating "C" element supplying negative feedback to the summing junction. R26 and R Span set the full scale current and determine system scaling.

3.5.5 Zero Crossing Amplifier

The zero crossing amplifier is a two-stage broadband, DC amplifier that detects the zero crossing of the integrator amplifier. R24 is a current limiter that prevents overload to the integrator or damage to Q9. Q9 and Q10 are common emitter amplifiers and work as a linear amplifier during the AUTO-ZERO mode. The typical loop gain is 50,000.

3.5.6 Zero Crossing Detector/Dual Differentiator

The zero crossing detector squares up the amplified zero crossing signal to provide a logic level

transition at the exact moment the integrator output crosses zero. Q9 and Q10 form the detector and feed a logic high level (for positive input signals) or low (negative input signals) to inverter Z24(13). Z24 feeds Z14(8) whose outputs (pins 10 and 13) are fed into dynamic AND gates and are differentiated. The resulting waveforms are fed to pin 6 of Z15.

The dual differentiator provides a brief "unipolar" reset pulse to reset the L_R flip-flop whenever the zero crossing detector detects a change in polarity from either direction.

3.5.7 Auto-Zero

The auto-zero circuit consists of a sample and hold circuit. R30 and R31 transfer the zero crossing amplifier output voltage to the input of Q11. Q11 switch is controlled by D3 and couples this voltage to the storage capacitor, C13. Q12 is a high input impedance source follower that supplies the correction voltage, E_c, to the integrator. When an encoding starts Q11 is turned off, and the last voltage required to zero the system is stored on C13, thus assuring a continuous correction voltage is applied to the integrator throughout the encoding.

3.5.8 Reset Generator

The reset generator is a monostable multivibrator formed by a dynamic NOR gate followed by two flip-flops. The positive going edge of either L_1 or L_R logic levels cause a brief low level signal to appear at Z14-4. This transition resets Z30(5) which, in turn, resets Z30(3). 50 μsecs later, the negative going edge of the 20 KHz at Z30(9) will strobe Z30(5) and toggle it to the positive state, removing the reset clear input at Z30(13). 25 μsecs later, the negative going edge of the 40KHz at Z30(12) will strobe Z30(3) high and Z30(2) low, ending the reset cycle.

3.5.9 Clock

The clock consists of a single transistor Q20 with positive feedback. The clock frequency is set at 400KHz. Inverter Z24, pins 10 and 11, acts as a clock buffer. The 400KHz clock is tunable.

3.5.10 Digital Circuitry

The circuits generating L_1, L_R, L_Z and L_0 pulses are TTL integrated circuits and synchronized logic circuits. The L_1 latch starts the encoding in synchronism with the master clock. The integration of the unknown input signal is ended after 200 msec. In the following 50 μsecs, the polarity is determined; then the L_R flip-flop begins the reference cycle. At the end of the reference cycle, which is detected by the zero crossing circuitry, the encode complete signal is sent and the measured input is displayed. The instrument displays the reading until the next encoding is completed.

3.5.11 Display Counter

The display counter consists of five identical decades. Each decade is comprised of one 8421 BCD counter, quad D flip-flop, and a BCD to decimal decoder-driver. The counter accepts pulses from Z29 (10) and divides the input frequency by ten. The output from the 8 bit is fed to the next decade. All four bits (8,4,2,1) are fed to the storage registers comprised of five quad D flip-flops. When the hold pulse from Z20 (13) goes from low to high, the information is latched onto the flip-flops. The Q outputs of the flip-flops are then inputed to the BCD to decimal decoder-drivers, for conversion from a BCD input to a decimal output suitable to drive the seven segment displays.

3.5.12 Polarity Detection

Information used for determining polarity is available on the L_Z and $\overline{L_Z}$ lines at the beginning of L_R. This information is provided to the polarity flip-flop (Z37, pins 1 and 4). During the reset period preceding t_2 time, the negative trailing edge of $\overline{L_R}$ + R causes the polarity information to be set into Z37. If Z37(2) is high the minus sign will be illuminated, indicating the negative polarity.

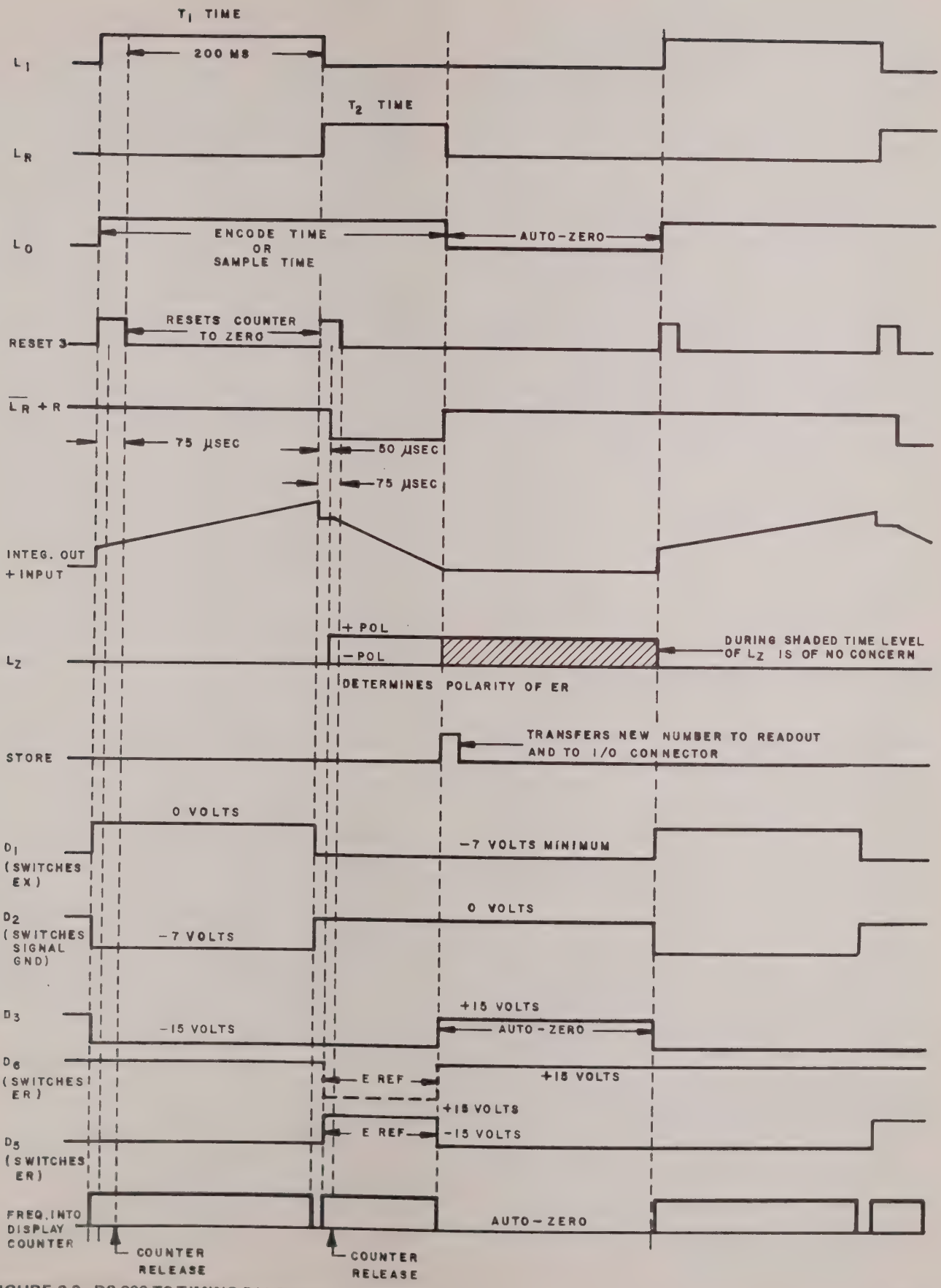


FIGURE 3-3. DS-300-T2 TIMING DIAGRAM

3.5.13 Decimal Point Selection

CMOS and gate Z17, tri-state buffer Z18, transistor Q40, and programming jumpers S3A through S3F are used to select a decimal point and provide the logic to the drivers on the Display Board to prevent blanking beyond the first digit to left of the decimal point. When the decimal point is selected by the TSU option, a high input impedance is provided by the CMOS Z17 and Q40 (when installed). Installing a programming jumper at S3G causes both pins 2 and 3 of the Display Board to go low displaying a fixed zero in the rightmost display (digit six). If no jumper is installed in S3G, both pins 2 and 3 are at logic high causing digit six to be blanked. When the $\overline{\text{TEST}}$ line from Display Board pin 38 is taken low, storage registers Z2, Z4, Z5, Z12, and Z13 are reset. Also one input of and gates Z17a, b, c, and d is forced low, causing each decimal point to light.

3.5.14 Overload Detection

An overload condition is detected when T2 time exceeds a preset time limit (T3). The T3 time base is generated by a monostable multivibrator formed by transistors Q36 and Q38 and associated components. Since the T3 pulse width is determined by the series resistance of R184, R195 and the parallel capacitance of R77A and R77B, changing the setting of R184 changes the pulse width. The T3 time begins when $\overline{\text{LR}} + \text{R}$ signal goes low and ends when the monostable multivibrator times out or when a new T1 time begins, whichever occurs first. The overload status is stored in one-half of flip-flop Z27. If a high logic level (T3 time out) is applied to pin 12 of Z27 at the time of its clock (end of T2) time, an overload condition is detected. This state is held until a new reading is taken at the end of the next measurement cycle. The Q output (pin 9) of Z27 is applied to the Display Board. Presence of an overload signal causes a line of minuses (dashes) to appear on the display. Since overload is determined by the time of T2, it is not affected by count by status of the display counter. So, an overload setting of 20,000 for CB-1 becomes 40,000 CB2, or 100,000 CB5.

3.5.15 Display Board

The Display Board contains the gas discharge displays, drivers, PROM IC, and a +180V voltage regulator. The drivers decode the BCD information from the storage registers into seven segment code for the display units. PROM Z1 and driver Z2 control (−) sign placement, and blanking of inputs from drivers Z3 through Z8. Drivers Z3 through Z6 provide leading zero blanking. The zero or non-zero status of each driver is presented to PROM inputs A0 through A3. When a negative sign is indicated, input A6 of the PROM is driven to a high logic state, causing the output of Z1 to go high through driver Z2 and illuminate the g(−) segment of the blanked digit nearest the first displayed digit. Display I2 is always illuminated as is I1 when it is activated. When input A5 of the PROM goes high indicating an overload condition, output 01 of the PROM goes high turning off transistor Q1 and causing all outputs from Z3 through Z8 to blank. Instead outputs from driver Z2 causes the g(−) segments of all displays but one to illuminate. If the overload is positive, I7 is not on. If the overload is negative I6 is blank. When option 28 is installed, closing the test switch causes A7 of the PROM to go low. This signal also resets the storage registers on the mainboard to zero. The displays are thus presented all zeros which illuminate six segments of each display, the seventh g(−) segment is turned on by driver Z2 assuring a test of each segment of all displays. Display I7 is only used to display a (−) sign, so only the g(−) segment of this display is tested. The decimal points of displays I2 through I6 are also illuminated during the closure of the test switch. These decimal points are controlled by outputs from drivers Z2, Z7 and Z8. Placement of a programming jumper on the main board determines which if any of these decimal points are used during normal operation. If display I1 is to be used (fixed zero) all four of the BCD inputs to driver Z8 are low. If I1 is to be blanked, these inputs are set to a high logic state. Installation of a programming jumper on the main board causes the fixed zero to be displayed.

3.6 T2 PLUG-ON BOARD

In order to display strain gage bridge outputs, the following circuit blocks are required on the T2 plug-on board. (Refer to Figure 3-4 and Schematic.)

3.6.1 Excitation Power Supply

The excitation power supply is a completely floating DC supply with respect to the other power supplies of the instrument. It is used to supply the required excitation voltage to the load cell strain gage transducer bridges. It uses a series regulator and a series pass power transistor. The supply is variable, current limited, short circuit proof, highly regulated and can provide excitation voltage for up to eight parallel load cells at one time. It employs sense amplifiers to maintain the specified voltage at the load cell terminals (instead of delivering the desired voltage at the instrument which may be several hundred feet away from the signal source). The supply offers 5, 10, 15 or 18 VDC for excitation of almost any load cell bridge.

3.6.2 Input Filter

The filter/limiter circuitry consists of a three pole active filter with an overload protection limiter, which is in the filter. The limiter prevents high voltage from damaging the input stage by limiting the input to ± 2 volts. The filter offers maximum AC rejection for a given settling time. See Section 2.9.10 for changing the filter response.

3.6.3 Remote Sense Amplifiers

Since the transducer will draw significant current, the voltage at the transducer may not be the same as the voltage at the power supply due to lead resistance. The transducer output voltage is proportional to the voltage applied at the transducer, this applied voltage must be measured by a high impedance device and relayed to the readout device. This is accomplished by remote sense amplifiers Z3 and Z4.

3.6.4 Reference Voltage

The reference voltage is generated by the balanced differential stage amplifier which will maintain a fixed reference voltage for a selected excitation voltage. The sensitivity is controlled by a selected span resistor, which provides the reference voltage to the A/D converter in required proportion to the full scale voltage output of the bridge. The span resistor should be selected not to exceed 1 microvolt/digit sensitivity to minimize the effect of low level noise and drift and to assure noise free, stable readout display. (R Span is discussed further in Section 5.2.)

3.6.5 Bridge Balance Controls

The bridge balance is a potentiometric bucking voltage circuit with a bridge balance (or zero) control covering ± 300 counts at 1μV per count. The range of this control is independent of excitation voltage, due to the ratiometric measuring technique, but is inversely proportional to the instrument sensitivity. (An adjustment range of ± 3% of a nominal full scale range of 10,000 counts.) The range of ± 300 counts is independent of transducer sensitivity mV/V and desired number of full scale counts.

The balance network is a high impedance offset circuit directly usable with foil and wire strain gage bridge devices. Shunt balance methods are avoided. A fixed offset up to 100% (Tare load) may be introduced by placing a resistor (R Tare) across the R Tare threaded, screw-on terminals. (See Section 5.3 for R Tare calculations.)

3.6.6 R Cal Test Switch

After the bridge has been properly balanced and calibrated, a precision resistor may be installed across the R cal threaded, screw-on terminals. When the factory installed R Cal test switch (Option 08) is depressed, the R Cal resistor will be switched in parallel across one leg of the bridge. This causes an electrical unbalance equivalent to a known physical load. This load may be used to check calibration or for recalibration. The selection of the R Cal resistor is discussed in Section 5.6.

3.6.7 X1, X2, X5 Circuitry

This is a digital circuit which, by suitable jumper position, allows the clock frequency to be modified during the reference cycle. The clock pulses are sent in either groups of two or five so that the counting steps are changed without increasing the resolution of the instrument.

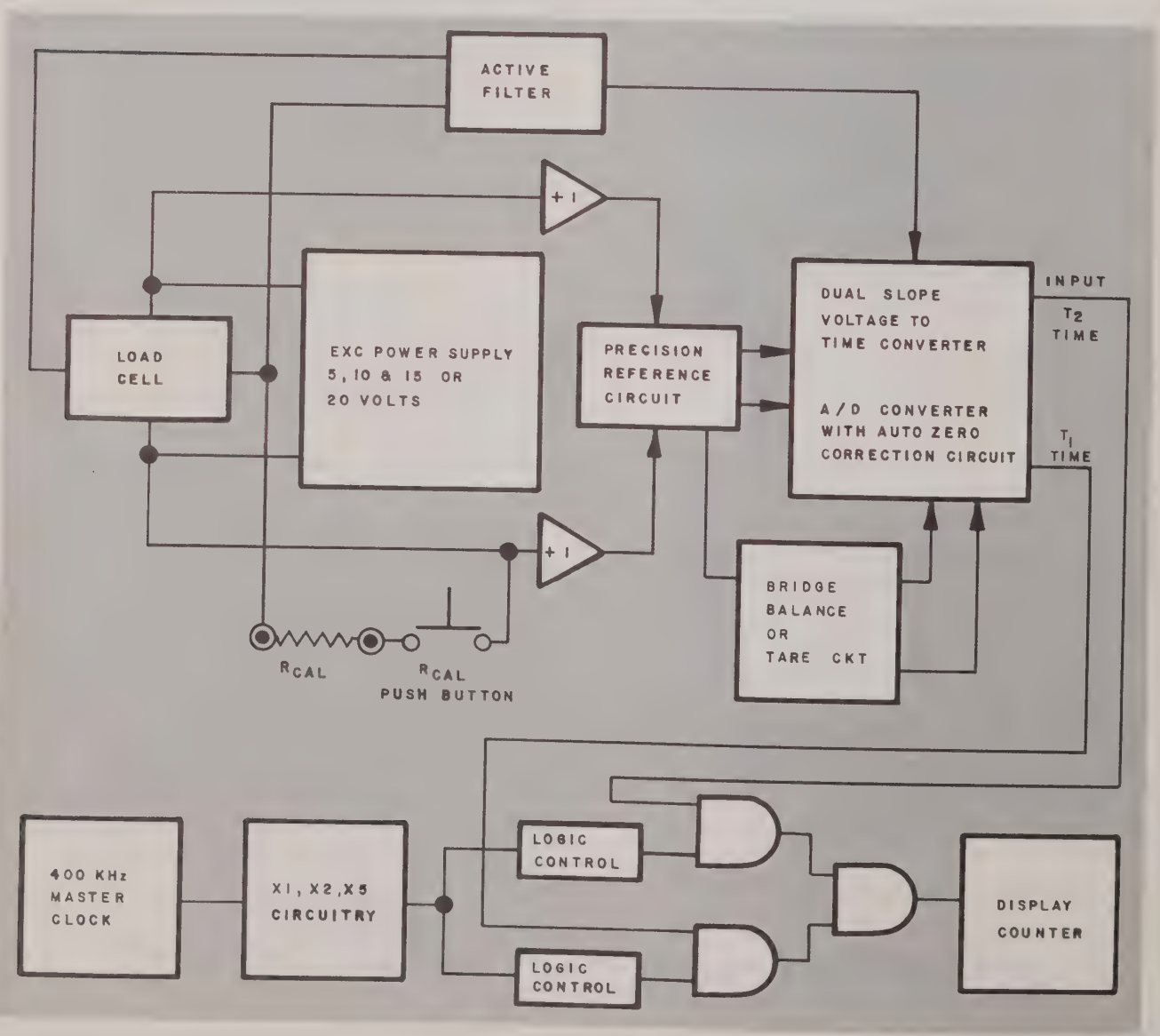


FIGURE 3-4. DS-300-T2 BLOCK DIAGRAM

SECTION 4

*OPTIONS

* See addendum, back page of this manual.

4.1 ISOLATED BCD OUTPUTS (Option S6P)

The I/O Board can be either factory installed or installed in the field by a technician. This isolated, digital output board provides guard crossing through the use of optical couplers (See Schematic S6P). It is a plug-on option board that is connected electrically to the instrument using 14 Elco pins.

The I/O Board has four optical coupler channels. These four channels are used to isolate the zero crossing detection information and control signals of the instruments inside (analog) ground from the outside (digital) ground. Three of these channels transfer information from outside of the instrument to the inside, and one channel is used to transfer zero crossing information from inside to the outside.

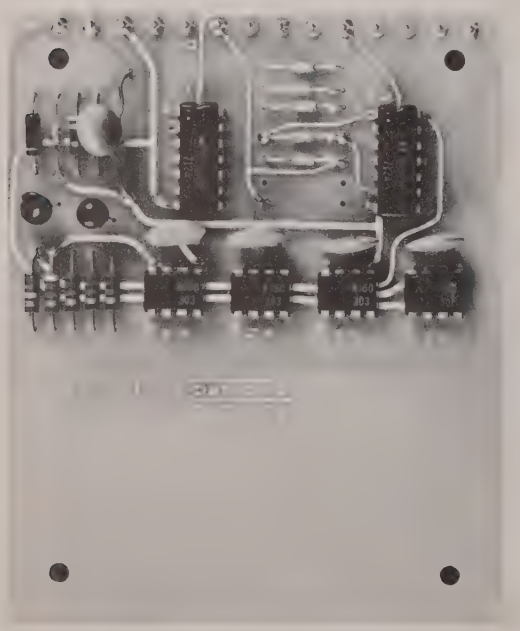


FIGURE 4-1. ISOLATED BCD OUTPUT BOARD (OPTION S6P)

When the signal on the input side of the optical coupler is low, the light emitting diode inside the IC will conduct supplying base drive to the output stage of the coupler. This base drive will turn the output transistor on, clamping its output to a logic "0." An inverter then provides the complementary signal. The inside logic used +5V with respect to -15V (analog ground) whereas the outside logic uses +5V with respect to digital ground.

4.2 ANALOG OUTPUT (Options 13 and 13-1)

Analog Output is a plug-on board assembly that is connected in parallel with the input signal being measured by the DS-300-T2. It provides an output at Connector J2, pins 9 (HI) and 4 (LO). This output is directly proportional to the exact output of the transducer being measured and can be used to drive a floating or grounded analog indicator or recorder.

The output section of this option is powered by a floating power supply that is completely separate from the internal operating supplies of the DS-300-T2. This feature enables the analog output to be used with grounded output devices. Because the LO output of this option is not at the same potential as the LO input to the DS-300-T2, but is at the same potential as -EXC of the load cell, it can be used with floating output devices. However, it is recommended that these outputs be treated as grounded outputs whenever possible. The floating power supply used aids in eliminating ground loops

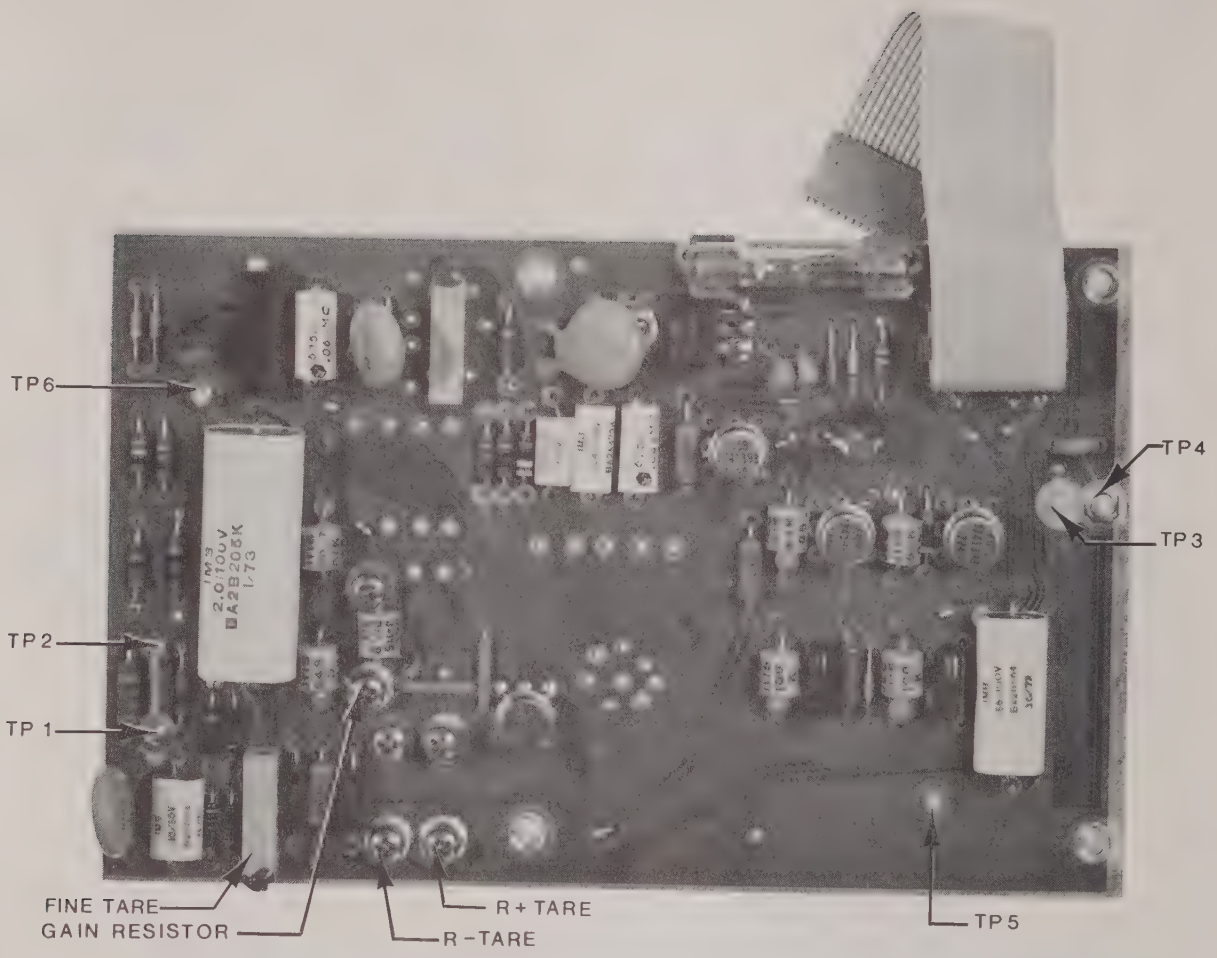


FIGURE 4-2. ANALOG OUTPUT BOARD, OPTION 13

and any deterioration in noise rejection specifications.

The amplification factor of the DC amplifier used in this option is nominally 100, ± 0.1% (10V output), but may be adjusted, in the field, for any gain up to 1000; the only limitation is that the analog output voltage must not exceed 10V full scale.

TARE is an integral part of the circuitry. The analog output is directly proportional to the readout. All controls and adjustments are located on the option board and are accessible by sliding the main instrument out of the chassis approximately six inches.

Since applications vary, there are two types of analog output options. Option 13 uses a Bi-Polar, transistor input, DC amplifier and has been signed to operate in applications where source impedance does not exceed 1000 ohms. Option 13-1 uses a chopper amplifier and can operate with source impedances of 0 to 50,000 ohms. All specifications for both types of Analog Output Option are shown in Figure 4-4.

There are two adjustment controls; zero (tare) and gain (span). The fine tare control, R30, provides only ±2% range for zero (tare) adjustment. In the event more tare is required, provisions have been made for installation of a tare resistor across two threaded screw-on terminals on the option board (see Figure 4-2 or 4-3).

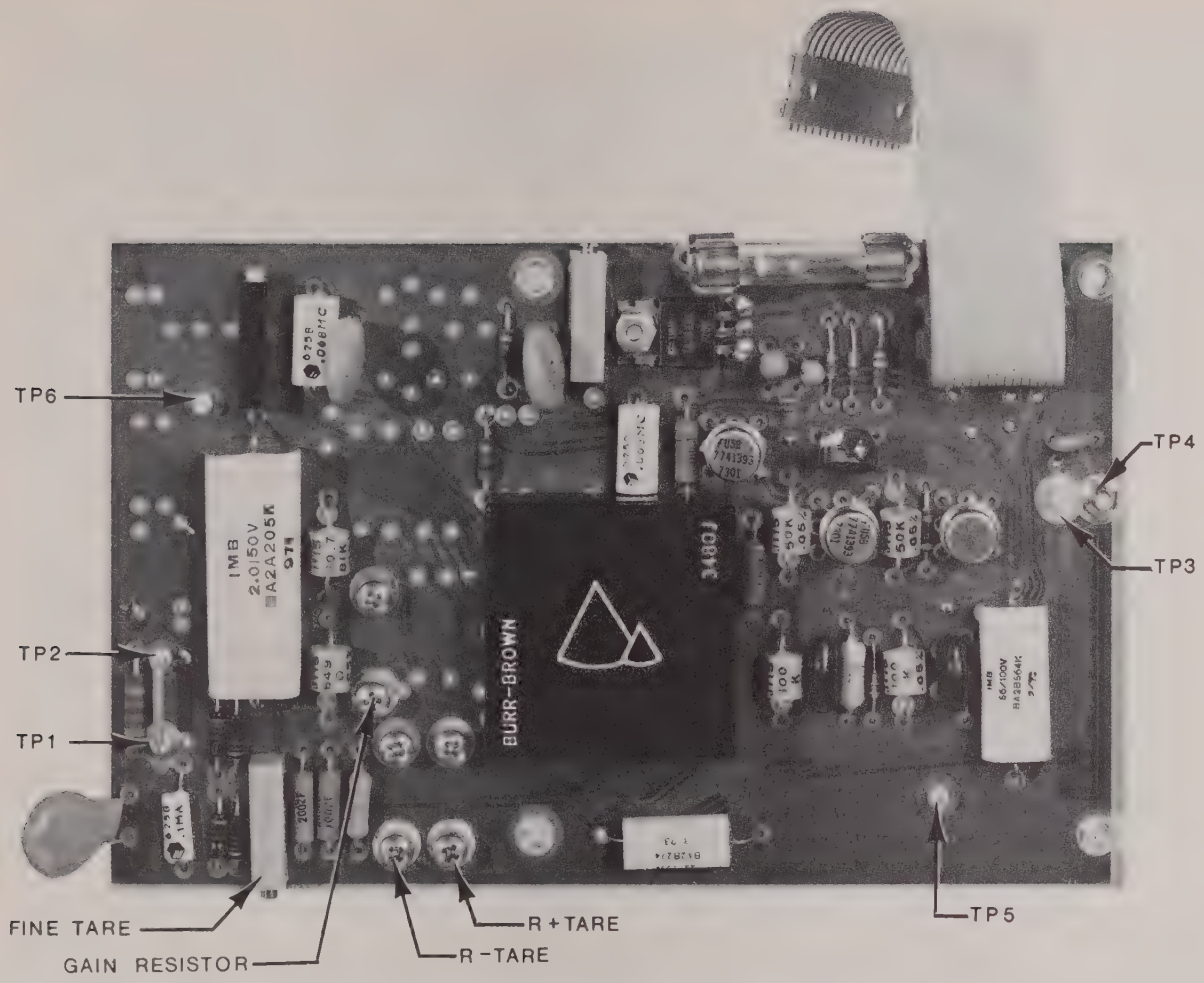


FIGURE 4-3. ANALOG OUTPUT BOARD, OPTION 13-1

The gain adjustment, R11, provides an adjustment range of ±3% of the full scale gain setting. The initial adjustment of the gain should be performed by a resistor selection corresponding to the gain desired. This resistor should be installed across the two-threaded screw-on terminals provided on the option board. Selection of the gain resistor should be performed prior to the selection of the tare resistor. Both the gain resistor and the tare resistor should be precision wire-wound resistors with a tempco of 10 ppm/°C or better.

Calculation of the gain resistor can be performed by using the following formula:

$$\text{R Gain} = \frac{63563}{\text{Desired System Gain} - 100}$$

e.g., for a gain of 1000 (10 millivolts in = 10 volts out)

$$\text{R Gain} = \frac{63562}{1000 - 100} = \frac{63562}{900}$$

R Gain = 70.624 ohms

Once the gain resistor has been chosen, the tare resistor may be calculated using the following formula:

$$\text{R Tare} = \frac{(0.6 - K \bullet p \bullet 10^{-5} \bullet (E)}{K \bullet p \bullet 10^{-5}}$$

Where R41 = The coarse gain resistor in ohms

Where K = The exact sensitivity of the load cell as specified by the

manufacturer (e.g., load cell specified as 4.035 mV/V then K = 4.035).

Where P = The tare desired as a percentage of full scale, (e.g., tare is to be 20% of full scale, then p = 20).

$$\text{Where E} = \frac{648.58 \bullet R41}{648.58 + R41}$$

After computing and installing the coarse R Tare and R Gain resistors across the appropriate screw-on terminals, the fine tare (zero) can be calibrated by adjusting the fine tare control R30. Once the system is zeroed, it may then be scaled for full scale. This full scale calibration may be performed by adjusting the gain control R11.

NOTE: Because of the slight interaction between the tare and gain controls, it is recommended that a repetitive calibration approach be followed. Perform the final adjustments of zero and gain as follows:

a. Adjust fine tare
b. Adjust gain
c. Readjust fine tare
d. Readjust gain
e. Touch up the fine tare, if necessary
f. Touch up the gain, if necessary

In most cases only two repetitions will suffice. No more than three repetitions should ever be required. The tare and gain controls are accessible from the side of the instrument after sliding it out of the chassis.

All connections, to or from the analog outputs, should be made with a two-wire plus shield coax (twisted shielded pair). The shield or guard wire should be connected to the guard pin at the recorder, if the recorder is guarded. If the recorder is not guarded, the shield should be connected at the guard pin (Connector J1(8) of the DS-300-T2).

The amplifier Z1 can either be DC, Bi-Polar transistor input amplifier or a chopper amplifier depending on which option (Option 13 or 13-1) is specified. This amplifier will amplify the transducer output by one-half the total system gain. The offset trimpot R7 is adjusted at the factory, if this option is factory installed, to null out the zero offset of Z1. External tare offsets are balanced out by summing in currents at the summing junction through the tare control, R30, and the coarse tare resistor. Z2 and Z4 act as the unity gain buffer for the differential output signal from the transducer. Z4 is a balanced differential output stage providing a gain of 2. It also transfers the analog output signal from a reference with the internal power source to the floating ±18V source used on the option board. This enables the output to be truly floating.

The gain of the whole system is divided to allow the first stage to have an amplification of only one-half the total gain and the second stage an amplification 2. This is done to assure good zero stability and ±10V at the output with good common mode voltage.

4.3 MOTION DETECTOR (Option 18)

The Motion Detector is a factory installed subassembly for use with the DS-300-T2 to allow compliance with requirements H-44 in USA and O. I. M. L. in Europe. It is installed inside the DS-300-T2 and is electrically connected using a 16 conductor cable. This option is an all solid-state design.

This option has been designed to prevent printout from occurring until a standstill condition exists. This is accomplished by outputting a logic low ($\overline{\text{Motion}}$) signal until the difference between two consecutive readings has remained within a presettable number of counts (D) for a presettable time (T). Except for the initial adjustment of (D) and (T), no operator intervention is required.

To inhibit the sample complete signal when motion is detected, the signal is wired to the DTL output signal.

The Tolerable Amplitude Variation (D) is internally adjusted from 00 to 99, in increments of one, on a rotary, BCD switch, which acts as a data entry device. Because all positions on the switch are active, a setting of 00 will give an allowable motion of ±00 digits at the readout, causing "motion" to always be detected. Therefore, the

DC GAIN:

Standard factory gain setting of 10 volts output. Variable from 100 to 1000 by customer installation of a fixed precision resistor.

GAIN ACCURACY:

Nominally greater than 0.01% of input.

GAIN STABILITY:

0.004% of setting per °C if gain and tare resistors are precision wire-wound resistors with a tempco of 10ppm/°C or better.

BANDWIDTH:

Option 13: Nominally limited to 20 Hz.

Option 13-1: 3Hz with chopper amplifier.

INPUT OFFSET VOLTAGE:

± 5 microvolts with an output of ± 10V from analog outputs. Adjustable with R30.

ZERO STABILITY:

Option 13: 1.4 microvolts/°C max. ± .002% of tare setting/°C.

Option 13-1: < 1 microvolt/°C ± .002% of tare setting/°C.

ZERO STABILITY WITH TIME:

Better than ± 5 microvolts at input per 1000 hours. With coarse tare of 0 to 100% better than ± 2 microvolts at input per 24 hours at 77°F ± 2°F.

INPUT BIAS CURRENT:

Option 13: Compensated to 10 namps. Variation in temperature = < .5 namps/°C.

Option 13-1: < 300 picoamps with chopper amplifier. Variation of 10 picoamps/°C maximum.

INPUT NOISE:

DC to 10 Hz = 1.5 μV peak-to-peak.

INPUT IMPEDANCE:

Greater than 10 megohms. Addition of this option reduces the input impedance of the DS-300-T2 to approximately 10 megohms.

INPUT PROTECTION:

Accomplished with fuse on option board and clamping diodes. 100 VDC or 115 VAC continuous at input with no damage.

OUTPUT CHARACTERISTICS:

Short circuit proof, differential or isolated. May be operated floating or earth grounded. Grounded output will not deteriorate the CMR of the DS-300-T2 to less than 120 db. Short circuit current limited to ± 12 mA. Output wideband noise is 400 μV RMS maximum.

COMMON MODE CHARACTERISTICS:

Allowable limits of ± 10 volts minus 0.5 times the excitation voltage. Common Mode Rejection ratio is 70 db at 59Hz with 100 ohm unbalance in either the HI or LO load and with a system gain of 100.

WARMUP TIME:

Initial warmup time of 2 hours. All performance specifications valid only after warmup.

FILTER CHARACTERISTICS:

2 pole, passive, corner frequency of 4Hz. As low as 2 Hz upon special order.

FIGURE 4-4. PERFORMANCE SPECIFICATIONS, ANALOG OUTPUT OPTION

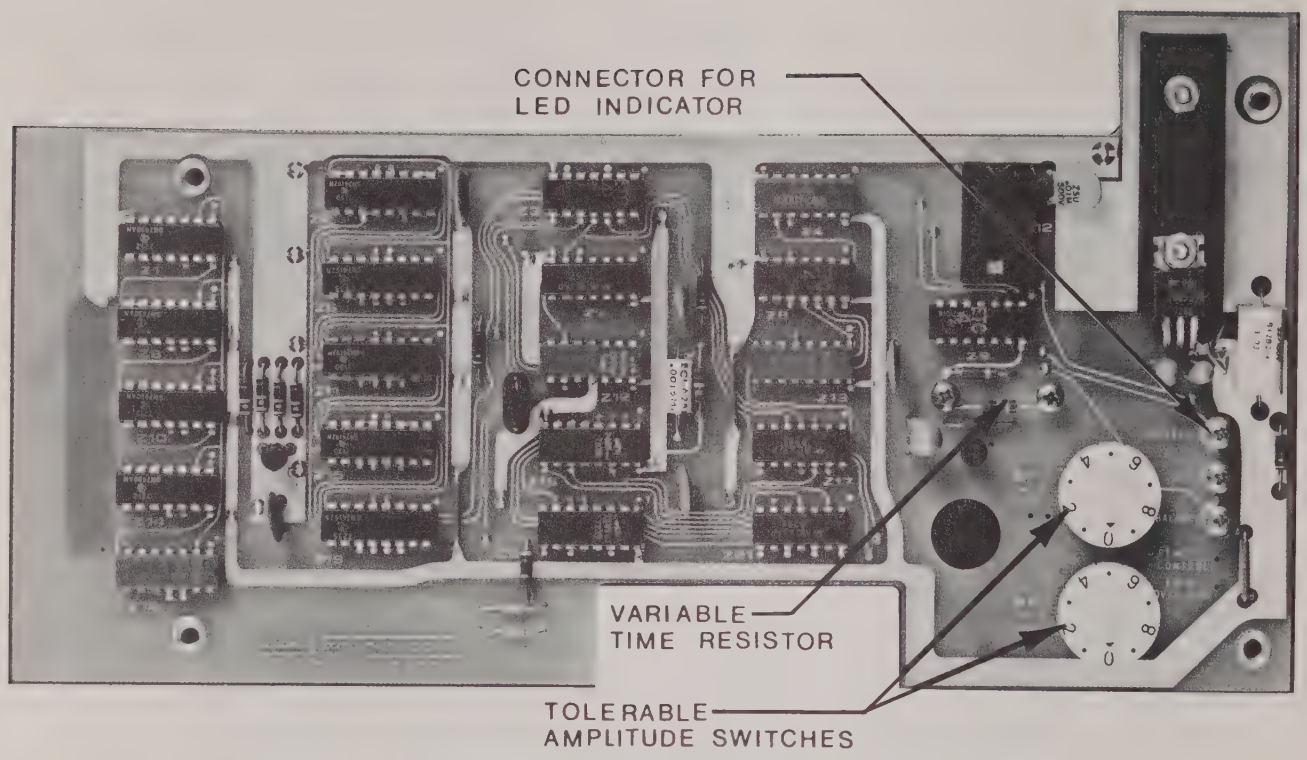


FIGURE 4-5. MOTION DETECTOR BOARD, OPTION 18

switches should be set from 01 to 99 counts. The motion detector will detect only variations greater or less than that of (D) in the three least significant decades of the DS-300-T2's readout.

The In Balance Time (T) is internally adjusted by selection of a resistor value. The two consecutive readings must be in the tolerable limit (D) for a minimum of In Balance Time (T) before "No Motion" can be detected. This resistor value can be chosen from the following values. Once the value has been chosen, it should be installed across the two threaded screw-on terminals located on the option board.

Time "T" (±20%)	Approx. Res. Value
0.6 seconds	51K
1	75K
2	150K
3	220K
4	300K
5	390K

Unless specified, factory installed time "T" will be 2 seconds, 150 K ohms.

The LED indicator is normally wired to be illuminated during a "Motion" condition but may also be wired to be illuminated during a "No Motion" condition upon request.

The effect of the motion detector can be remotely controlled by switching pins 17 ($\overline{\text{Motion Override}}$) to 15 (Digital Ground) of Connector J1. This closure overrides the motion detector, permitting a sample complete signal to occur with every encoding, regardless of any motion of the scale.

To facilitate understanding of the theory of operation, let us assume the instrument has been sampling. At the beginning of an encoding (Rd2) the load command pulse at Z8(6) transfers the contents of the auxiliary counters to the up/down counters. The information now being stored in the up/down counters is that information obtained during the encoding prior to Rd2; for ease of understanding, we will refer to the previous encoding as Rd1. At the end of Rd1, the polarity information of Rd1 was also stored in Z4 flip-flop. At the

beginning of the reference cycle of Rd2, the polarity of Rd2 is compared with that of Rd1. If they are the same, Z7(3) will go true; if they are not the same, Z7(3) will go false.

The auxiliary counters are reset at the beginning of each encoding by the inverted output of Z8. After they are reset, they begin counting until the number equal to the input signal being measured is reached. At the same time, if the "SAME" line from Z7(3) is true, the up/down counters will begin counting down from the Rd1's previously stored information. If all counters pass through zero, a borrow pulse from Z2(3) sets Z12 and sets the "U/D control" line to a "0" state. The up/down counters will then begin to count back from 00000. The counting continues in this fashion until the end of the sample period. If the polarities were different, the up/down counters would have counted up from the beginning of the reference cycle rather than down.

The counts left over or accumulated in the up/down counter at the end of Rd2 are then applied to the comparator. The other input to the comparator is the BCD coded information that corresponds to the Tolerable Amplitude Variation "D." S1 is the units switch and S2 is the tens switch.

The first encoding Rd1 is used as a reference basis for the comparison. The accumulation of the pulses during the encoding period of Rd2 is done in proper up/down counting sequence until a true difference Rd1 – Rd2 or Rd2 – Rd1 is achieved. If the difference is arithmetically greater-than or less-than "D," the "Motion" signal from Z17(8) will go high indicating an error and the "Verify Time Mono" will be set with each encoding. If "No Motion" is indicated, the mono will eventually time out indicating that all sets of consecutive readings were within the Tolerable Amplitude Deviation (D) for the preset time (T).

The motion detector operates over three decades. The two least significant decades are sent to the comparator and the third decade is sensed by Z22. It is important to know that, if there is a difference in the fourth decade but the last three decades are within the tolerable deviation, a "No Motion" condition will result.

When setting the initial adjustments and if X2 of X5 functions are being used, it will be necessary to set the exact number of digits to be detected in the BCD switches, not the active counts. For example: the DS-300-T2 has a full scale capability of 20,000 counts. If X2 is used, that capability becomes 40,000 even though the active counts still equal 20,000. Therefore, if a motion of 2 counts is required, then D = 2 x 2 = 4.

4.4 SPAN RESISTOR NETWORK (Option 24)

The initial setup of the DS-300-T2 requires a span resistor to be installed on screw terminals provided on the T2 Option Board. In cases where the exact load cell operating point is unknown at time of order (or where it is not practical to stock precision wire-wound resistors for selection purposes), the selectable resistor network (Option 24) is available at extra cost.

A single, fixed precision resistor and a binary-weighted, six-resistor shunting network are mounted on a small circuit board, which may be attached directly to the R Span screw terminals on the DS-300-T2 Option Board. An array of six jumpers, cut in any of 64 patterns, provide approximately a 3-to-1 resistance range. To prevent degradation in span stability with temperature, only precision, high-stability, wire-wound resistors are used.

In practice, the desired R Span is calculated according to the formula shown in Section 5 of this manual, and the nearest R Span value found on the appropriate schematic. Schematic Diagram 300-696-XX covers 6.0 to 20.4 microvolts per count with 15 V excitation, while Schematic 300-6961-XX covers 1.9 to 6.4 microvolts per count with 15 V excitation. Schematic 300-6962-XX is for 0.75 to 1.88 microvolts per count with 15 V excitation. The jumpers are cut according to the table shown on the schematic. In case of system changes or errors in calculation, the value of R Span may be altered by reconnecting cut jumpers and cutting a new pattern.

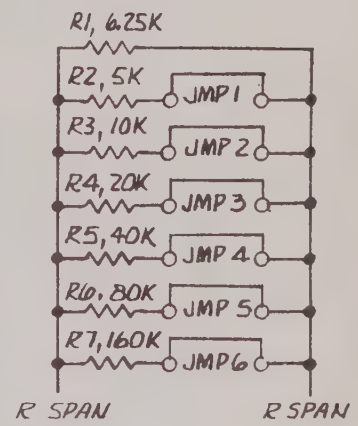
The internal fine span pot provides approximately ± 2.5% adjustment range which is more than adequate to allow continuous adjustment between the R Span values in the network.

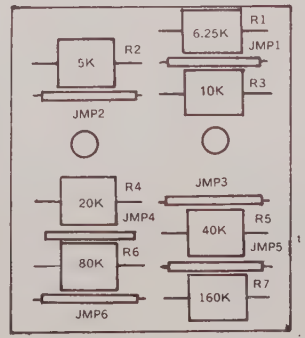
JUMPER DELETION CHART

JMP1	JMP2	JMP3	JMP4	JMP5	JMP6	R SPAN
						1.806
					X	1.826
				X		1.848
				X	X	1.869
			X			1.891
			X		X	1.914
			X	X		1.937
			X	X	X	1.961
		X				1.985
		X			X	2.010
		X		X		2.036
		X		X	X	2.062
		X	X			2.089
		X	X		X	2.116
		X	X	X		2.145
		X	X	X	X	2.174
	X					2.204
	X				X	2.235
	X			X		2.266
	X			X	X	2.299
	X		X			2.332
	X		X		X	2.367
	X		X	X		2.402
	X		X	X	X	2.439
	X	X				2.477
	X	X			X	2.516
	X	X		X		2.556
	X	X		X	X	2.597
	X	X	X			2.640
	X	X	X		X	2.685

JMP1	JMP2	JMP3	JMP4	JMP5	JMP6	R SPAN
	X	X	X	X		2.730
	X	X	X	X	X	2.778
X						2.827
X					X	2.878
X				X		2.930
X				X	X	2.985
X			X			3.042
X			X		X	3.101
X			X	X		3.162
X			X	X	X	3.226
X		X				3.292
X		X			X	3.361
X		X		X		3.433
X		X		X	X	3.509
X		X	X			3.587
X		X	X		X	3.670
X		X	X	X		3.756

JMP1	JMP2	JMP3	JMP4	JMP5	JMP6	R SPAN
X		X	X	X	X	3.846
X	X					3.941
X	X				X	4.040
X	X			X		4.145
X	X			X	X	4.255
X	X		X			4.372
X	X		X		X	4.494
X	X		X	X		4.624
X	X		X	X	X	4.762
X	X	X				4.908
X	X	X			X	5.063
X	X	X		X		5.229
X	X	X		X	X	5.405
X	X	X	X			5.594
X	X	X	X		X	5.797
X	X	X	X	X		6.105
X	X	X	X	X	X	6.250





ASSEMBLY 300-4960-00
OPTION 24-1

2. (X) INDICATES CLIPPED JUMPER.
1. RESISTORS VALUES ARE K Ω.

NOTES: (UNLESS OTHERWISE SPECIFIED.)

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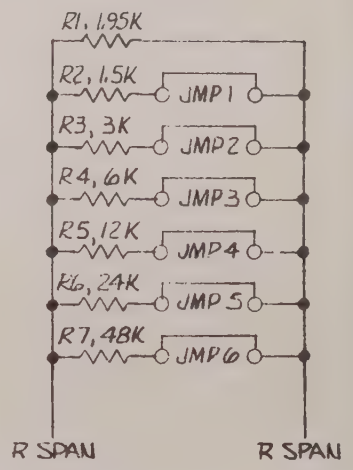
SPAN BOARD
OPTION 24-1
1.806K TO 6.25K
SCHEMATIC 300-6960-00

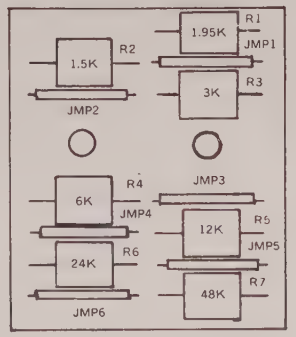
JUMPER DELETION CHART

JMP1	JMP2	JMP3	JMP4	JMP5	JMP6	R SPAN
						548Ω
					X	554Ω
				X		561Ω
				X	X	567Ω
			X			574Ω
			X		X	581Ω
			X	X		588Ω
			X	X	X	595Ω
		X				603Ω
		X			X	611Ω
		X		X		618Ω
		X		X	X	627Ω
		X	X			635Ω
		X	X		X	643Ω
		X	X	X		652Ω
		X	X	X	X	661Ω
	X					670Ω
	X				X	680Ω
	X			X		690Ω
	X			X	X	700Ω
	X		X			710Ω
	X		X		X	721Ω
	X		X	X		732Ω
	X		X	X	X	743Ω
	X	X				755Ω
	X	X			X	767Ω
	X	X		X		779Ω
	X	X		X	X	192Ω
	X	X	X			805Ω
	X	X	X		X	819Ω

JMP1	JMP2	JMP3	JMP4	JMP5	JMP6	R SPAN
	X	X	X	X		833Ω
	X	X	X	X	X	848Ω
X						863Ω
X					X	879Ω
X				X		895Ω
X				X	X	912Ω
X			X			930Ω
X			X		X	948Ω
X			X	X		967Ω
X			X	X	X	987Ω
X		X				1.008
X		X			X	1.030
X		X		X		1.052
X		X		X	X	1.076
X		X	X			1.101
X		X	X		X	1.126
X		X	X	X		1.153

JMP1	JMP2	JMP3	JMP4	JMP5	JMP6	R SPAN
X		X	X	X	X	1.182
X	X					1.212
X	X				X	1.243
X	X			X		1.276
X	X			X	X	1.311
X	X		X			1.348
X	X		X		X	1.387
X	X		X	X		1.428
X	X		X	X	X	1.472
X	X	X				1.518
X	X	X			X	1.568
X	X	X		X		1.621
X	X	X		X	X	1.677
X	X	X	X			1.738
X	X	X	X		X	1.803
X	X	X	X	X		1.874
X	X	X	X	X	X	1.95





ASSEMBLY 300-4961-01
OPTION 24-2

2.(X) INDICATES CLIPPED JUMPER.
1. RESISTOR VALUES ARE KΩ.
NOTES: (UNLESS OTHERWISE SPECIFIED)

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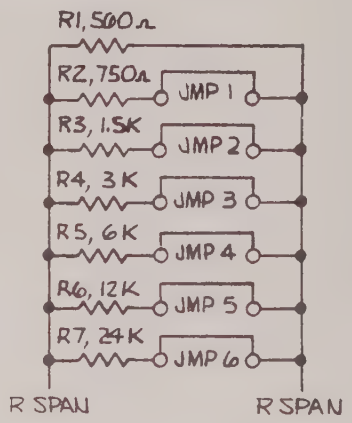
SPAN BOARD
OPTION 24-2
317 Ω TO 1.95K
SCHEMATIC 300-6961-01

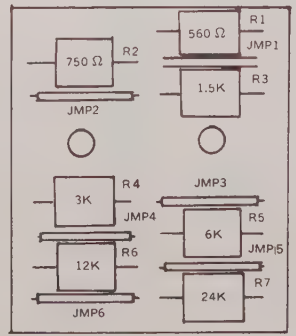
JUMPER DELETION CHART

JMP 1	JMP 2	JMP 3	JMP 4	JMP 5	JMP 6	R SPAN
						227
					X	229
				X		231
				X	X	233
			X			236
			X		X	238
			X	X		240
			X	X	X	243
		X				245
		X			X	248
		X		X		250
		X		X	X	253
		X	X			256
		X	X		X	258
		X	X	X		261
		X	X	X	X	264
	X					267
	X				X	270
	X			X		273
	X			X	X	276
	X		X			280
	X		X		X	283
	X		X	X		286
	X		X	X	X	290
	X	X				293
	X	X			X	297
	X	X		X		301
	X	X		X	X	304
	X	X	X			308
	X	X	X		X	312

JMP 1	JMP 2	JMP 3	JMP 4	JMP 5	JMP 6	R SPAN
	X	X	X	X		316
	X	X	X	X	X	321
X						325
X					X	329
X				X		334
X				X	X	339
X			X			344
X			X		X	349
X			X	X		354
X			X	X	X	359
X		X				364
X		X			X	370
X		X		X		376
X		X		X	X	382
X		X	X			388
X		X	X		X	394
X		X	X	X		401

JMP 1	JMP 2	JMP 3	JMP 4	JMP 5	JMP 6	R SPAN
X		X	X	X	X	408
X	X					415
X	X				X	422
X	X			X		430
X	X			X	X	437
X	X		X			446
X	X		X		X	454
X	X		X	X		463
X	X		X	X	X	472
X	X	X				481
X	X	X			X	491
X	X	X		X		501
X	X	X		X	X	512
X	X	X	X			523
X	X	X	X		X	535
X	X	X	X	X		547
X	X	X	X	X	X	560





ASSEMBLY 300-4962-00
OPTION 24-3

2. (X) INDICATES CLIPPED JUMPER.
1. RESISTOR VALUES ARE K Ω

NOTES: (UNLESS OTHERWISE SPECIFIED)

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SPAN BOARD
OPTION 24-3
227 Ω TO 560 Ω
SCHEMATIC 300-6962-00

SECTION 5

CALIBRATION

5.1 GENERAL

The DS-300-T2 uses a two-step calibration procedure: adjusting the zero and adjusting the span. However, prior to performing this two point calibration, a few calculations must be performed to accomplish the initial set-up of the instrument. These calculations are for the coarse span resistor, coarse tare resistor and if the R Cal option has been incorporated, the R Cal resistor.

5.2 SPAN RESISTOR (R Span)

The first step in the initial set-up of the DS-300-T2 is the selection of the span resistor. The span resistor will affect the number of counts at full scale and is a direct function of the transducer's sensitivity. For proper operation of the instrument the span resistor MUST BE INSTALLED.

To obtain the proper value of R Span for any application first obtain the K/N ratio.

Example: $\frac{K}{N} = ?$

Where K = the exact transducer gage factor as specified by the transducer manufacturer, (e.g., if the transducer is specified as 4.035 mV/V then K will equal 4.035).

Where N = the number of full scale active counts corresponding to a fully loaded load cell, (e.g., a fully loaded load cell with a rated 2000 lbs. capacity. If the DS-300-T2 uses X1 operation and does not contain the fixed zero option, divide 2000 lbs. by 1 and use N = 2000).

Then: $\frac{4.035}{2000} = \frac{0.002017}{}$

In some cases the full scale load applied to the load cell may not be the full scale readout desired, (e.g., a load cell rated at 2000 lbs. maximum load; an applied load of 1500 lbs.; a desired readout of 1000 lbs.). If this occurs a "load factor" must be used when calculating the K/N ratio. K will always remain the exact transducer gage factor for the fully loaded load cell specified by the manufacturer (e.g., K = 4.035).

Example: $\frac{K}{\text{desired readout in Active Counts} \bullet \frac{\text{full scale rating of load cell}}{\text{actual applied load to the load cell}}}$

$$\frac{4.035}{1000 \bullet \frac{2000}{1500}} = \frac{4.035}{1000 \bullet 1.3333} =$$

$$\frac{4.035}{1333.30}$$

$$\frac{K}{N} = \frac{4.035}{1333.3} = \frac{0.0030263}{}$$

Now that the K/N ratio is known it is possible to obtain the R Span resistor value. In Section 7 of this manual, there is a table containing two and one-half pages of R Span vs. K/N ratios. By taking the K/N ratio (e.g., 0.002017) and finding the number that is either equal to, or closest to, the K/N ratio, the proper resistor value will be given (e.g., the closest number to 0.002017 is 002015, therefore R Span = 9347.73 ohms).

When computing the N of this ratio it will be necessary to consider X2, X5 and use of the dead zero option. If X2 or X5 is used, 2 or 5 must be divided into the quantity equal to the capacity of the fully loaded load cell (e.g., N = 2000/2 = 1000 for X2 operation). If the fixed zero is installed a division using 10, 20, 50 (X1, X2, X5 respectively) should be used rather than 1, 2 or 5 (e.g., with X2 and fixed zero N = 2000/20 = 100).

When using the "load factor" method the use of 1, 2, 5 or 10, 20, 50 should be performed to achieve the N portion of the calculation (e.g., if the desired readout in the active counts is 1000 lbs. and we are using the X2 option with a fixed zero, then instead of using 1000 we would use 50). This is accomplished by dividing 1000 by 20.

When using the R Span tables, it should be noted that the maximum sensitivity is nominally 1 microvolt per digit. Because of this, the following limits are the smallest R Span resistor values permitted for the associated excitation power supplies:

5 volt excitation = 895.594 ohms
10 volt excitation = 446.632 ohms
15 volt excitation = 297.489 ohms
20 volt excitation = 223.018 ohms

The R Span resistor should be a precision wire-wound resistor with a tempco better than 10 ppm/°C.

Once the proper resistor value for R Span has been obtained, place the resistor across the two threaded, screw-on terminals located on the T2 plug-on board. See Figure 2-10 for location.

When using the Model TSU Transducer Switching Unit, with the DS-300-T2, it will be necessary to consult the calibration section in the TSU Manual for computation of R Span for the DS-300-T2.

5.3 BRIDGE BALANCE (R Tare)

In some cases, the offset (or tare), caused by dirt, moisture, or simply a preload on the weigh bridge will be of such a quantity that the zero control of the instrument will not have enough range to zero the instrument. To help decide if your application requires this resistor, perform the following:

a. Place the transducer in an unloaded state or the desired state that requires a readout of all zeroes.

b. Adjust the DS-300-T2 zero control or front panel tare control until the readout displays ±00000.

c. If the instrument will not zero, computation of an R Tare resistor will be necessary.

There are two types of zero controls available with the DS-300-T2: (1) trimpot zero control available either as a front panel adjustment or as an internal adjustment (Option 20); and (2) an additional front panel tare control (Option 07) which features a long life, 10 turn pot with locking knob for applications requiring frequent operator adjustment of zero. Both controls have the same range, ± 300 counts at 1μV/count. Regardless of the type of control, R Tare must be computed according to the R Tare formula below.

NOTE: R Tare formula differs from that in previously manufactured DS-300-T2's because the tare circuitry has been altered to provide simultaneous tare for the digital readout and the analog output options.

$$R_{TARE\ (In\ Ohms)} = \frac{12{,}000 \times \text{Excitation Voltage}}{(\text{mV of Tare Desired})} - 20$$

Example: A 1000 pound load cell of 3 mV/V output full scale is operated at 15V excitation. A Tare of 200 pounds is needed.

1000 pounds = 15V X 3 mV/V = 45 mV
200 pounds = 1/5 X 45 mV = 9 mV

$$R_{TARE} = \frac{(12{,}000)(15)}{9} - 20 = 19{,}980 \text{ ohms}$$

After performing the above calculation, it will now be necessary to install the tare resistor in the correct location. There are two available locations for R Tare. They are R + TH and R – TH (See Figure 2-10).

The R Tare resistor should be a precision wire-wound resistor with a tempco better than 10 ppm/°C. In some cases where tare is less than 10% of full scale, a resistor with a 1% tolerance and a tempco better than 25 ppm/°C may be used.

If the offset to be compensated was positive, the R Tare resistor will be installed in R + TH.

NOTE: See addendum, back page of this manual.

5.4 ADJUSTING ZERO

Once the correct value of R Tare has been installed in the appropriate location on the T2 plug-on board, calibration of the zero control may be performed. Place the load cell in the desired state that will require a readout of all zeros. Adjust either the zero vernier control or the Front Panel Tare Control until the readout displays 00000. The DS-300-T2 is now zeroed.

5.5 ADJUSTING THE SPAN

Now that the DS-300-T2 has been zeroed and the R Span resistor is installed, you are ready to set (or adjust) the span to the actual sensitivity of the load cell being used.

To perform this adjustment, apply a known physical load to the load cell. This physical load should not exceed the specified rating of the load cell and should not be less than one-half of that rating (e.g., for a load cell rated at 2000 lbs. the physical load should be no greater than 2000 lbs. and no less than 1000 lbs.).

With the physical load applied, adjust the span control until the desired readout is indicated on the DS-300-T2. It is possible to calibrate span using the R Cal pushbutton rather than applying a physical load. This is accomplished by depressing the R Cal pushbutton at which time a known resistor value is shorted across one leg of the bridge giving a millivolt output to the DS-300-T2. (NOTE: The load cell must be connected when using R Cal.) This millivolt output acts like a mechanical load. To compute the value of R Cal, see Section 5.6.

NOTE: Because of a slight interaction between the zero control and span control it may be necessary to recheck zero. If it has shifted, reset zero and reset span.

5.6 R CAL

After the DS-300-T2 has been properly calibrated, a fixed precision resistor may be shunted across one leg of the bridge by depressing the R Cal pushbutton on the front panel. This pushbutton is available as Option 08. This shunt will produce an electric unbalance in the bridge that can be considered equivalent to a known physical or mechanical load. This unbalance can be used for calibrating or recalibrating the instrument without the necessity of applying a physical load to the load cell. However, for optimum accuracy, it is recommended an actual physical calibration, using the load cell, should be used. R Cal can then be used to periodically recheck calibration.

The actual value of R Cal may be determined as follows:

a. The transducer is accurately calibrated at the time of manufacture. The R Cal value (or actual resistor) is frequently supplied with the transducer by the manufacturer. This step can be accomplished by installing the resistor across the two threaded screw-on terminals provided for the R Cal resistor on the T2 plug-on board.

b. Because installation may alter the system calibration, the user can duplicate the transducer's calibration procedure after installation, first by calibrating the DS-300-T2 using a known physical load and second by installing the R Cal resistor across the provided terminals. Depressing the R Cal pushbutton will then display a reading. Although this reading may not be equivalent to the reading that the DS-300-T2 was calibrated for, it may be

recorded and used for recalibration or rechecking calibration.

c. Occasionally, however, a user will have to calculate R Cal. If this is the case, the R Cal resistor may be calculated to an approximate figure using the following formula.

$$R\ Cal = \frac{25000 \bullet Rb}{K \bullet E} - .5 \bullet Rb$$

Where K = the transducer sensitivity at full scale (e.g., where full scale sensitivity is 4 mV/V use K = 4).

Where E = the electrical equivalent, % of full scale load desired for a full scale readout (e.g., if a fully loaded transducer is to be used as the full scale readout, then E = 100%. Half loaded as full scale readout, use E = 50%).

Where R_b = bridge resistance in ohms

Example: Say K = 4 mV/V, E = 40%, R_b = 350 ohms

$$R\ Cal = \frac{25000 \bullet 350}{4 \bullet 40} - .5 \bullet 350$$

$$R\ Cal = \frac{8750000}{160} - 175$$

$$R\ Cal = 54687.5 - 175 = 54512.5$$

Once the R Cal resistor has been computed it may be installed across the two threaded screw-on terminals provided on the T2 plug-on board for the R Cal resistor. This resistor should be a precision wire-wound resistor with a tempco of 10 ppm/°C or better.

SECTION 6

TROUBLESHOOTING

6.0 INTRODUCTION

Because the DS-300-T2 has been completely tested and pre-aged, with respect to temperature variations, at the factory, it is unlikely that it will need any repairs during its lifetime. In the event a failure does occur, this section on troubleshooting has been incorporated to aid in locating any fault.

This section has two types of fault location guides. One is a basic guide that will give you a specific symptom and two or three faults that may cause that symptom. The other guide is an in-depth fault isolation program that, when systematically followed, will normally allow location of a bad part or section.

In either case, it is recommended that a review of the theory of operation section be accomplished prior to troubleshooting the DS-300-T2.

6.1 TEST EQUIPMENT

To effectively troubleshoot the DS-300-T2, it will become necessary to use one or more of the following test equipment.

a. Oscilloscope
b. Ohmmeter
c. Voltmeter
d. MV/V substitution box (strain gage bridge simulator)

6.2 BASIC TROUBLESHOOTING

The basic troubleshooting guide has been designed to help troubleshoot the DS-300-T2 without going in-depth. Prior to performing the basic guide, it is recommended that a check list be followed to aid in locating a fault.

a. Check all fuses (internal and external).
b. Check visually for burned components.
c. Check all system interconnections.
d. Check for validity of field selected functions.
e. Check all connections used in making field selections of certain functions.
f. Ensure all Elco pins are properly seated and check continuity.

After you are sure the instrument is properly connected and all function selections are valid, a careful study and comparison of your instrument's symptoms to the symptoms shown in the basic guide will aid in locating the fault. See Figure 6-1 .

6.3 FAULT ISOLATION PROGRAM

The following fault isolation program, when systematically followed, will locate a malfunction in any part of the instrument. Each item, in each sequence, contains a question, the answer to which is either yes or no. Each answer will lead to the next step or path in the program, logically eliminating each possibility until the fault is located.

In some cases it will be necessary to remove the T2 plug-on board to make specific checks. If this occurs, extender cables must be used. See Section 6.4 for more information concerning Troubleshooting Accessories.

6.4 TROUBLESHOOTING ACCESSORIES

6.4.1 By-Pass Connector

When the DS-300-T2 has been modified to work with the DS-305, disconnecting the DS-305

from the Connector J9 of the DS-300-T2 will render the DS-300-T2 inoperative. Doric offers a By-Pass Connector to aid in troubleshooting the DS-300-T2 independent of the DS-305. By replacing the interconnecting cable that exists between the DS-300-T2 and the DS-305 with this By-Pass Connector, the DS-300-T2 will operate normally. The By-Pass Connector should be connected to Connector J9 of the DS-300-T2. The pin connections are as follows: at Connector J9 jumper pins 5 to 11, 7 to 19, 2 to 15 and 1 to 24. J9 is a 24 pin female Amphenol connector. The By-Pass-Connector is a 24 pin male amphenol connector (57-30240) and is supplied with all DS-300-T2s that are modified to work with the DS-305.

6.4.2 Troubleshooting Kit (Option 22)

To effectively troubleshoot the DS-300-T2, Doric offers a troubleshooting kit. Contained in this kit are: two jumpers, extender cables for removing the T2 plug-on board and a dummy I/O strip. For information regarding price and delivery time, contact either Doric Scientific or one of Doric's representatives.

To allow troubleshooting, it may be necessary to remove the T2 plug-on board. If this case does arise, Doric offers extender cables to allow for removal of the T2 plug-on board. The cables are labeled for ease of installation.

If the I/O Board, (part of the Isolated BCD Outputs, Option S6P), has been incorporated in the DS-300-T2, it may be necessary to remove it when troubleshooting the DS-300-T2. To facilitate operation of the DS-300-T2 without the I/O board installed, Doric offers a dummy I/O strip which replaces the I/O board. To install this dummy strip, remove the I/O board and replace it with the dummy strip, ensuring that the two wires provided on the strip are connecting to the Elco pins closest to the front panel of the instrument.

6.5 TROUBLESHOOTING SUGGESTIONS

When troubleshooting the DS-300-T2, all tests and measurements should be made with care. Because there is 190 volts going to the digital display, it is recommended that the DS-300-T2 be turned OFF, allowing several seconds for the power supply capacitors to discharge, whenever hooking a test lead to a specific component. All tests should be made in a logical sequence, thus allowing for efficient location of the fault. When making any repairs or part changes, be sure the correct replacement part is used. There is a complete parts list incorporated with this manual in Section 8 .

If the DS-300-T2 cannot be repaired, it is recommended that Doric Scientific be notified and arrangements for return of the instrument back to Doric be made. Follow the packing instructions in Section 2.2 when repacking the instrument for return.

All schematics and assembly drawings for the DS-300-T2 and associated option boards are located in Section 7 of this manual.

BASIC TROUBLESHOOTING GUIDE

	SYMPTOM		POSSIBLE FAULT
1.	Display won't light	A.	No 190 volts
		B.	Faulty line fuse
2.	Display is not stable	A.	+ 5 volt supply out of regulation
		B.	±15 volts supply faulty
		C.	Improper system grounding
		D.	Clips on rear panel connectors touching the rear panel
		E.	Invalid selection of functions
3.	Display runs around (does not respond to input)	A.	Improper hook up
		B.	Open input
		C.	Faulty input FET Q2
		D.	Q16 faulty
		E.	L_1 signal bad
4.	Instrument will not zero	A.	Improper hook up
		B.	Improper tare resistor value
		C.	Instrument needs tare resistor
		D.	No excitation
5.	Instrument will not read read desired full scale	A.	Improper span resistor
		B.	Improper hook up

FIGURE 6-1. BASIC TROUBLESHOOTING GUIDE

NORMAL POWER SUPPLY VOLTAGES AND LOAD RESISTANCES

Nominal Voltage (Volts)	Actual Voltage (Volts)	Load Resistance (Analog Section)	Load Resistance (Digital Section)
+8V	8V ± 2V	10 K ohms	- - - -
+25V, (unregulated)	+25 ± 5V	- - - - -	5K
-25V, (unregulated)	-25 ± 5V	- - - - -	- - - -
+15V	+15 ± 0.75V		5K
-15V	-15 ± .75V		2K
+5V digital	+5 ± .25V	- - - - -	300 ohms
+190V	+190 ± 20V	40K ohms	- - - -
Excitation, Unregulated	28V + 6V	- - - - -	- - - -
+5V EXC	5V ± .35V	- - - - -	- - - -
+10V EXC	10V ± .7V	- - - - -	- - - -
+15V EXC	15V ± 1V	- - - - -	- - - -
+20V EXC	20V ± 1.5V	- - - - -	- - - -

NOTE: Load resistances should be measured with the power off. All load resistances should be measured with respect to analog ground except +5V and +8V which are measured with respect to the applicable digital ground. The ohmmeter terminal must have the same polarity as the power supply being measured. These measurements are to be made with an ohmmeter having a 1.5V voltage source, and set on RX100 scale. See Figure 2-11 for convenient ground locations.

AUTO-ZERO CONDITION CHECKOUT CHART

Logic Level	Logic State	Ref step # in the main program for trouble-shooting aid
S. R. G. (Q21) (Sample Rate Generator)	0	107
L_1	0	8
L_0	0	8
L_R	0	8
L_Z	1	8

Logic State "0" corresponds to 0 volts to +.8 volts relative to digital ground.

Logic State "1" corresponds to 2.4 volts to 5.0 volts relative to digital ground.

Analog Test Pin	Voltage (Volts)	Ref Step No.
Q_4 FET source	0V	108
Integrator out Z40 pin 6	-.6V±.2V	109
Zero amp out Q10 collector	-5V ± 5V	110
Auto-Zero Q12 drain	0 ± 3V	111
D_1 (Q16) collector	-5V to -12V	108
D_2 (Q19) collector	0	108
D_3 (Q17) collector	+15V	108
D_5 (Q18) collector	-15V	108
D_6 (Q15) collector	0 to + 15V	108

NOTE: The Auto-Zero condition is set by applying + 5 volts to R62 or grounding Q21 collector. Disconnect this line after Auto-Zero test.

FIGURE 6-2. POWER SUPPLY VOLTAGES & AUTO-ZERO CHART

STEP NO.	PROCEDURE	IF YES GO TO NUMBER	IF NO GO TO NUMBER
1	Are all power supplies OK?	6A	2
2	Are all loads normal per Figure 6-2 ?	3	6
3	Are all fuses OK?	5	4
4	Replace fuses with exact ratings specified. Return to Step 1.	---	---
5	Analyze bad power supplies. Correct fault. Return to Step 1.	---	---
6	Analyze bad load. Correct fault. Return to Step 1.	---	---
6A	Do all digital ICs receive +5 volts and digital ground services?	7	6B
6B	Analyse supply path. Restore continuity. Return to Step 2.	---	---
7	Set meter in Auto-Zero mode by connecting +5V to hold line connected to Z19(13). Compare circuit conditions the same as shown on Figure 6-2 . After all conditions agree, take meter out of Auto-Zero mode.	8	Go to step associated with bad condition
8	Apply a full scale input to the DS-300-T2 using a MV/V substitution box. Go to Step 9.	---	---
9	Check filter circuit. Is output at Elco H12 the same as Elco H11?	9A	10
9A	Do you see any oscillations in the filter circuit?	11	10
10	Refer to schematic and theory of operation. Analyze and correct fault. Return to Step 9.	---	---
11	Check reference voltage circuit. Is E_{REF} equal to 0.6 Excitation?	13	12
12	Analyze reference circuit. Check Z3, Z4, Z5 and Z26. Go to Step 13.	---	---
13	Check span pot and wiper contacts for proper continuity. Go to Step 14.	---	---
14	Check zero pot, wiper contacts and tare circuit voltage levels. Go to next step.	---	---
14A	Does L_1 oscillate?	15	31
15	Does D_1 pulse turn Q6 on and off?	18	16
16	Replace Q6. Go to next step.	---	---
17	Not used. Go to next step.	---	---

FIGURE 6-3. FAULT ISOLATION PROGRAM

STEP NO.	PROCEDURE	IF YES GO TO NUMBER	IF NO GO TO NUMBER
18	Does $\overline{L_1}$ positive going transition fire $\overline{L_R}$?	19	59
19	Does $\overline{L_R}$ fire $\overline{L_R}$ + R?	20	28
20	Does $\overline{L_R}$ and R turn on Q15 or turn Q18 off respectively?	20A	83
20A	Does Q15 or Q18 turn either Q14 or Q13 on respectively?	21	83
21	Is the polarity of the zero crossing amplifier the same as the integrator?	22	83
22	When the integrator slews toward -5V, does it cause $\overline{L_2}$ and L_2 to change states?	23	83
23	When L_2 and $\overline{L_2}$ change states, is L_R reset to "0" via the dual differentiator?	24	101
24	Does the positive transition of $\overline{L_R}$ cut off clock pulses to the display counter?	25	65
25	Does the negative L_R transition fire L_0?	26	28
26	Does the L_0 pulse transfer counter information to the storage registers?	27	28
27	Does L_0 oscillate?	27A	62
27A	END OF ENCODING SEQUENCE If instrument agrees with all previous states but still does not work, recheck installation and interconnections. Notify Doric Scientific.	- - -	
28	Are all waveforms of previous circuits OK? Refer to Figure 3-3	29	30
29	Check operation of previous circuits in question. Correct fault. Return to step taken prior to 28.	- - -	- - -
30	Check operation of previous circuits. Correct fault. Return to step where malfunction was discovered.	- - -	- - -
31	Analyze sample rate generator circuit. Correct fault. Go to Step 32.	- - -	- - -
32	Does Z24(6) going positive cause L_1 to go false?	34	33
33	Replace Z19. Go to Step 32.	- - -	- - -
34	Does $\overline{L_1}$ false make L_1 true at Z19(1)?	36	35

FIGURE 6-3 (CONTINUED)

STEP NO.	PROCEDURE	IF YES GO TO NUMBER	IF NO GO TO NUMBER
35	Analyze Z19 circuit. Correct fault. Go to Step 36.	- - -	- - -
36	Does 400KHz clock oscillate?	38	37
37	Analyze circuit. Correct fault. Return to step where malfunction was located.	- - -	- - -
38	Does Z7 on T2 plug-on board send 80KHz to Z31(12) on Mother Board?	39	37
39	If the clock appears at Z31(12), does it give 40KHz at Z31(3) and 20KHz at Z31(5)?	40	41
40	Does Z32 toggle giving 10KHz at Z32(5)?	46	37
41	Does L_1 going true create a $\overline{\text{Reset 1}}$ pulse?	42	37
42	Does $\overline{\text{Reset 1}}$ pulse clear Z30 and Z31?	44	43
43	Replace Z30, Z31 and Z14 as needed. Go to Step 42.	- - -	- - -
44	Does Z31 now toggle?	46	45
45	Analyze Z31 circuit. Correct fault. Go to Step 44.	- - -	- - -
46	Is Reset 2 pulse 50 μsecs long and Reset 3 pulse 75 μsecs long?	48	47
47	Analyze Reset circuitry. Correct fault. Return to Step 46.		
48	Does Z9 on T2 plug-on board toggle?	49	50
49	Does Z8 on T2 plug-on board allow 40KHz to flow to the counters during L_1 time?	53	51
50	Analyze count-by circuitry. Correct fault. Return to Step 49.	- - -	- - -
51	Ensure 40KHz clock is at Z29(8) and that Z29(9) is low. Correct fault. Go to Step 52.	- - -	- - -
52	Ensure 40KHz is present at Z8(3) of T2 board. Go to Step 49.		
53	Does the 8 bit in 10^3 decade divide its input frequency by 10,000?	55	54
54	Analyze counters Z1, Z3, and Z11. Correct fault. Return to Step 53.	- - -	- - -

FIGURE 6-3 (CONTINUED)

STEP NO.	PROCEDURE	IF YES GO TO NUMBER	IF NO GO TO NUMBER
55	Does Z19(2) now have a signal and Z19(2) oscillate?	52	56
56	Analyze Z19 and associated circuitry. Correct any fault. Return to Step 55.	---	---
57	Does L_1 now oscillate?	14A	58
58	Replace Z19. Analyze loads on L_1 and L_1 lines. Correct fault. Go to Step 57.	---	---
59	L_1 circuit should be working. Ensure L_0 is true as long as L_1 is true. Go to Step 60.	---	---
60	Analyze all previous circuitry including sample rate generator. If all is operating correctly, go to Step 60A.	---	---
60A	Does the transition making L_1 go false and $\overline{L_1}$ true fire L_R.	19	61
61	Analyze L_R circuit. Correct fault. Go to Step 62.	---	---
62	Is Z19(10) now false whenever L_1 = "1" or L_R = "1"?	63	64
63	Is L_0 true whenever L_1 = "1" or L_R = "1"?	19	64
64	Analyze L_0 circuitry. Correct fault. Return to Step 63.	---	---
65	The L_R circuit should now work. Does Z9 flip-flop toggle?	67	66
66	Analyze X2 & X5 circuitry on T2 plug-on card. Return to previous step.	---	---
67	Does Z8 allow clock pulses to flow to the counters?	73	68
68	Is Elco 11, row F, at a logic "1"?	69	66
69	Ensure Z29 operates properly. Correct any fault. Go to Step 70.	---	---
70	Is the level at Z19(1) always opposite to that of Z15(1)?	72	71
71	Analyze Z15 and Z19. Correct fault. Return to Step 70.	---	---
72	Analyze Z8 circuitry and driver circuits on T2 plug-on card. Correct fault. Return to Step 67.	---	---
73	Does the 8 bit, 10^0 decade divide by 10? Check at Z11(9).	74	78
74	Does the 8 bit, 10^1 decade divide by 100? Check at Z11(7).	75	79

FIGURE 6-3 (CONTINUED)

STEP NO.	PROCEDURE	IF YES GO TO NUMBER	IF NO GO TO NUMBER
75	Does the 8 bit, 10^2 decade divide by 1000? Check at Z 3 (9).	76	80
76	Does 8 bit 10^3 decade divide input by 10,000? Check at Z 3 (7).	77	81
77	Does 8 bit, 10^4 decade divide input by 100,000? Check at Z 1 (7).	24	82
78	Analyze 10^0 decade counter. Correct fault and return to Step 62.	- - -	- - -
79	Analyze 10^1 decade counter, correct fault, and return to Step 63.	- - -	- - -
80	Analyze 10^2 decade counter, correct fault and return to Step 64.	- - -	- - -
81	Analyze 10^3 decade counter, correct fault, and return to Step 65.	- - -	- - -
82	Analyze 10^4 decade counter, correct fault, and return to Step 66.	- - -	- - -
83	Is integrator amplifier more positive than -.5V?	95	84
84	Is zero amplifier output approximately -13V?	85	99
85	Is pin 13 of Z14 true?	86	100
86	Is L_R true?	87	19
87	Is L_Z in opposite state of pin 13 of Z14?	88	97
88	Is $\overline{L_Z}$ in opposite state to L_Z?	89	98
89	Does $\overline{L_R}$ + R go low when L_R fires?	90	28
90	Is L_Z false?	91	92
91	Is Q13 on?	21	94
92	Is Q15 on?	21	93
93	Analyze Q15 circuit, correct fault, and return to Step 13.	- - -	- - -
94	Analyze Q18 circuit, correct fault, and return to Step 13.	- - -	- - -
95	Is output of zero amplifier approximately 0V?	96	99
96	Is pin 13 of Z14 false?	87	100
97	Check Z14, correct faults, and return to Step 76.	- - -	- - -
98	Check Z14, correct faults, and return to Step 77.	- - -	- - -

FIGURE 6-3 (CONTINUED)

STEP NO.	PROCEDURE	IF YES GO TO NUMBER	IF NO GO TO NUMBER
99	Analyze zero amplifier, correct faults, and return to Step 73 or Step 84.	- - -	- - -
100	Analyze Z14, correct fault and return to Step 74 or Step 85.	- - -	- - -
101	Is D_4 oscillation reaching pin 13 of Z24?	101	104
102	Is there a negative differentiated pulse on pin 6 of Z15?	103	105
103	Does $\overline{L_R}$ go true?	24	106
104	Trace oscillation through feedthrough circuit straps, etc.; correct fault and return to Step 93.	- - -	- - -
105	Analyze dual differentiator, correct fault and return to Step 94.	- - -	- - -
106	Analyze L_R - $\overline{L_R}$ flip-flop; correct fault and return to Step 95.	- - -	- - -
107	Refer to Theory of Operation. Analyze Sample Rate Generator circuit. Go to Step 8.	- - -	- - -
108	Refer to Theory of Operation. (Analog Switching) D_1 through D_6 signal generators. Go to Step 104.	- - -	- - -
109	Refer to Theory of Operation. Integrating Amp. Analyze and correct fault.	- - -	- - -
110	Refer to Theory of Operation. Zero Crossing Amp. Analyze and correct fault.	- - -	- - -
111	Refer to Theory of Operation Auto-Zero circuit.	- - -	- - -
112	Are the inputs to the analog switches OK? ($\overline{L_1}$ - HIGH; L_1 - LOW; L_R - LOW; L_Z - LOW; L_R + R - HIGH)	113	8
113	Analyze circuit in question, correct fault, and return to Auto-Zero chart.	- - -	- - -

FIGURE 6-3 (CONTINUED)

SECTION 7

TABLES; CHARTS; SCHEMATICS.

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Drawings

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300-4730	Mother Board Assembly
300-639	Plug-On Board Schematic
300-4390	Plug-On Board Assembly
300-6740	Display Board Schematic
300-4740	Display Board Assembly
300-625	Isolated BCD Output Board Schematic, Option S6P
300-425	Isolated BCD Output Board Assembly, Option S6P
300-6980	Analog Output Board Schematic, Option 13-1
300-4980	Analog Output Board Assembly, Option 13-1
300-6981	Analog Output Board Schematic, Option 13
300-4981	Analog Output Board Assembly, Option 13
300-665	Motion Detector Board Schematic, Option 18
300-465	Motion Detector Board Assembly, Option 18

FIGURE 7-1. R SPAN TABLE

EXCITATION (VOLTS)	LOWEST PERMISSIBLE VALUE OF R SPAN THAT CAN BE USED (OHMS)
5 V	896.11
10 V	446.88
15 V	297.65
18 V	223.14

RATIO K/N	RSPAN	RATIO K/N	RSPAN
.00005000	223.14	.00005760	257.11
.00005020	224.03	.00005780	258.00
.00005040	224.93	.00005800	258.90
.00005060	225.82	.00005820	259.79
.00005080	226.71	.00005840	260.69
.00005100	227.61	.00005860	261.58
.00005120	228.50	.00005880	262.47
.00005140	229.39	.00005900	263.37
.00005160	230.29	.00005920	264.26
.00005180	231.18	.00005940	265.16
.00005200	232.08	.00005960	266.05
.00005220	232.97	.00005980	266.94
.00005240	233.86	.00006000	267.84
.00005260	234.76	.00006020	268.73
.00005280	235.65	.00006040	269.63
.00005300	236.55	.00006060	270.52
.00005320	237.44	.00006080	271.42
.00005340	238.33	.00006100	272.31
.00005360	239.23	.00006120	273.20
.00005380	240.12	.00006140	274.10
.00005400	241.02	.00006160	274.99
.00005420	241.91	.00006180	275.89
.00005440	242.80	.00006200	276.78
.00005460	243.70	.00006220	277.68
.00005480	244.59	.00006240	278.57
.00005500	245.49	.00006260	279.47
.00005520	246.38	.00006280	280.36
.00005540	247.27	.00006300	281.25
.00005560	248.17	.00006320	282.15
.00005580	249.06	.00006340	283.04
.00005600	249.96	.00006360	283.94
.00005620	250.85	.00006380	284.83
.00005640	251.74	.00006400	285.73
.00005660	252.64	.00006420	286.62
.00005680	253.53	.00006440	287.51
.00005700	254.43	.00006460	288.41
.00005720	255.32	.00006480	289.30
.00005740	256.21	.00006500	290.20

RATIO K/N	RSPAN	RATIO K/N	RSPAN
.00006520	291.09	.00007580	338.51
.00006540	291.99	.00007600	339.41
.00006560	292.88	.00007620	340.30
.00006580	293.78	.00007640	341.20
.00006600	294.67	.00007660	342.09
.00006620	295.57	.00007680	342.99
.00006640	296.46	.00007700	343.89
.00006660	297.35	.00007720	344.78
.00006680	298.25	.00007740	345.68
.00006700	299.14	.00007760	346.57
.00006720	300.04	.00007780	347.47
.00006740	300.93	.00007800	348.36
.00006760	301.83	.00007820	349.26
.00006780	302.72	.00007840	350.15
.00006800	303.62	.00007860	351.05
.00006820	304.51	.00007880	351.94
.00006840	305.41	.00007900	352.84
.00006860	306.30	.00007920	353.73
.00006880	307.20	.00007940	354.63
.00006900	308.09	.00007960	355.52
.00006920	308.98	.00007980	356.42
.00006940	309.88	.00008000	357.31
.00006960	310.77	.00008020	358.21
.00006980	311.67	.00008040	359.10
.00007000	312.56	.00008060	360.00
.00007020	313.46	.00008080	360.89
.00007040	314.35	.00008100	361.79
.00007060	315.25	.00008120	362.68
.00007080	316.14	.00008140	363.58
.00007100	317.04	.00008160	364.47
.00007120	317.93	.00008180	365.37
.00007140	318.83	.00008200	366.26
.00007160	319.72	.00008220	367.16
.00007180	320.62	.00008240	368.06
.00007200	321.51	.00008260	368.95
.00007220	322.41	.00008280	369.85
.00007240	323.30	.00008300	370.74
.00007260	324.20	.00008320	371.64
.00007280	325.09	.00008340	372.53
.00007300	325.99	.00008360	373.43
.00007320	326.88	.00008380	374.32
.00007340	327.78	.00008400	375.22
.00007360	328.67	.00008420	376.11
.00007380	329.57	.00008440	377.01
.00007400	330.46	.00008460	377.90
.00007420	331.36	.00008480	378.80
.00007440	332.25	.00008500	379.70
.00007460	333.14	.00008520	380.59
.00007480	334.04	.00008540	381.49
.00007500	334.93	.00008560	382.38
.00007520	335.83	.00008580	383.28
.00007540	336.72	.00008600	384.17
.00007560	337.62	.00008640	385.96

FIGURE 7-1 (CONTINUED)

RATIO K/N	RSPAN	RATIO K/N	RSPAN	RATIO K/N	RSPAN	RATIO K/N	RSPAN
.00008680	387.75	.00010760	480.94	.00013300	594.87	.00015900	711.65
.00008720	389.55	.00010800	482.73	.00013350	597.12	.00015950	713.90
.00008760	391.34	.00010840	484.53	.00013400	599.36	.00016000	716.14
.00008800	393.13	.00010880	486.32	.00013450	601.60	.00016050	718.39
.00008840	394.92	.00010920	488.11	.00013500	603.85	.00016100	720.64
.00008880	396.71	.00010960	489.91	.00013550	606.09	.00016150	722.88
.00008920	398.50	.00011000	491.70	.00013600	608.34	.00016200	725.13
.00008960	400.29	.00011050	493.94	.00013650	610.58	.00016250	727.38
.00009000	402.08	.00011100	496.18	.00013700	612.83	.00016300	729.63
.00009040	403.88	.00011150	498.42	.00013750	615.07	.00016350	731.88
.00009080	405.67	.00011200	500.67	.00013800	617.32	.00016400	734.12
.00009120	407.46	.00011250	502.91	.00013850	619.56	.00016450	736.37
.00009160	409.25	.00011300	505.15	.00013900	621.81	.00016500	738.62
.00009200	411.04	.00011350	507.39	.00013950	624.05	.00016550	740.87
.00009240	412.83	.00011400	509.63	.00014000	626.30	.00016600	743.11
.00009280	414.62	.00011450	511.88	.00014050	628.54	.00016650	745.36
.00009320	416.42	.00011500	514.12	.00014100	630.79	.00016700	747.61
.00009360	418.21	.00011550	516.36	.00014150	633.03	.00016750	749.86
.00009400	420.00	.00011600	518.60	.00014200	635.28	.00016800	752.11
.00009440	421.79	.00011650	520.84	.00014250	637.52	.00016850	754.35
.00009480	423.58	.00011700	523.09	.00014300	639.77	.00016900	756.60
.00009520	425.38	.00011750	525.33	.00014350	642.01	.00016950	758.85
.00009560	427.17	.00011800	527.57	.00014400	644.26	.00017000	761.10
.00009600	428.96	.00011850	529.81	.00014450	646.50	.00017050	763.35
.00009640	430.75	.00011900	532.06	.00014500	648.75	.00017100	765.60
.00009680	432.54	.00011950	534.30	.00014550	651.00	.00017150	767.85
.00009720	434.33	.00012000	536.54	.00014600	653.24	.00017200	770.09
.00009760	436.13	.00012050	538.78	.00014650	655.49	.00017250	772.34
.00009800	437.92	.00012100	541.03	.00014700	657.73	.00017300	774.59
.00009840	439.71	.00012150	543.27	.00014750	659.98	.00017350	776.84
.00009880	441.50	.00012200	545.51	.00014800	662.22	.00017400	779.09
.00009920	443.30	.00012250	547.76	.00014850	664.47	.00017450	781.34
.00009960	445.09	.00012300	550.00	.00014900	666.72	.00017500	783.59
.00010000	446.88	.00012350	552.24	.00014950	668.96	.00017550	785.84
.00010040	448.67	.00012400	554.49	.00015000	671.21	.00017600	788.09
.00010080	450.46	.00012450	556.73	.00015050	673.45	.00017650	790.33
.00010120	452.26	.00012500	558.97	.00015100	675.70	.00017700	792.58
.00010160	454.05	.00012550	561.22	.00015150	677.95	.00017750	794.83
.00010200	455.84	.00012600	563.46	.00015200	680.19	.00017800	797.08
.00010240	457.63	.00012650	565.70	.00015250	682.44	.00017850	799.33
.00010280	459.43	.00012700	567.95	.00015300	684.69	.00017900	801.58
.00010320	461.22	.00012750	570.19	.00015350	686.93	.00017950	803.83
.00010360	463.01	.00012800	572.43	.00015400	689.18	.00018000	806.08
.00010400	464.81	.00012850	574.68	.00015450	691.43	.00018050	808.33
.00010440	466.60	.00012900	576.92	.00015500	693.67	.00018100	810.58
.00010480	468.39	.00012950	569.16	.00015550	695.92	.00018150	812.83
.00010520	470.18	.00013000	581.41	.00015600	698.17	.00018200	815.08
.00010560	471.98	.00013050	583.65	.00015650	700.41	.00018250	817.33
.00010600	473.77	.00013100	585.90	.00015700	702.66	.00018300	819.58
.00010640	475.56	.00013150	588.14	.00015750	704.91	.00018350	821.83
.00010680	477.35	.00013200	590.38	.00015800	707.15	.00018400	824.08
.00010720	479.15	.00013250	592.63	.00015850	709.40	.00018450	826.33

FIGURE 7-1 (CONTINUED)

RATIO K/N	RSPAN
.00018500	828.58
.00018550	828.58
.00018600	833.08
.00018650	835.33
.00018700	837.58
.00018750	839.83
.00018800	842.08
.00018850	844.33
.00018900	846.58
.00018950	848.83
.00019000	851.08
.00019050	853.33
.00019100	855.58
.00019150	857.83
.00019200	860.08
.00019250	862.34
.00019300	864.59
.00019350	866.84
.00019400	869.09
.00019450	871.34
.00019500	873.59
.00019550	875.84
.00019600	878.09
.00019650	880.35
.00019700	882.60
.00019750	884.85
.00019800	887.10
.00019850	889.35
.00019900	891.60
.00019950	893.85
.00020000	896.11
.00020050	898.36
.00020100	900.61
.00020150	902.86
.00020200	905.11
.00020250	907.37
.00020300	909.62
.00020350	911.87
.00020400	914.12
.00020450	916.37
.00020500	918.63
.00020550	920.88
.00020600	923.13
.00020650	925.38
.00020700	927.64
.00020750	929.89
.00020800	932.14
.00020850	934.39
.00020900	936.65
.00020950	938.90
.00021000	941.15
.00021100	945.66

RATIO K/N	RSPAN
.00021200	950.16
.00021300	954.67
.00021400	959.18
.00021500	963.68
.00021600	968.19
.00021700	972.70
.00021800	977.21
.00021900	981.71
.00022000	986.22
.00022100	990.73
.00022200	995.24
.00022300	999.75
.00022400	1004.25
.00022500	1008.76
.00022600	1013.27
.00022700	1017.78
.00022800	1022.29
.00022900	1026.80
.00023000	1031.31
.00023100	1035.82
.00023200	1040.33
.00023300	1044.84
.00023400	1049.35
.00023500	1053.86
.00023600	1058.38
.00023700	1062.89
.00023800	1067.40
.00023900	1071.91
.00024000	1076.42
.00024100	1080.94
.00024200	1085.45
.00024300	1089.96
.00024400	1094.47
.00024500	1098.99
.00024600	1103.50
.00024700	1108.02
.00024800	1112.53
.00024900	1117.04
.00025000	1121.56
.00025100	1126.07
.00025200	1130.59
.00025300	1135.10
.00025400	1139.62
.00025500	1144.13
.00025600	1148.65
.00025700	1153.16
.00025800	1157.68
.00025900	1162.20
.00026000	1166.71
.00026100	1171.23
.00026200	1175.75
.00026300	1180.26

RATIO K/N	RSPAN
.00026400	1184.78
.00026500	1189.30
.00026600	1193.82
.00026700	1198.33
.00026800	1202.85
.00026900	1207.37
.00027000	1211.89
.00027100	1216.41
.00027200	1220.93
.00027300	1225.45
.00027400	1229.97
.00027500	1234.49
.00027600	1239.01
.00027700	1243.53
.00027800	1248.05
.00027900	1252.57
.00028000	1257.09
.00028100	1261.61
.00028200	1266.13
.00028300	1270.65
.00028400	1275.17
.00028500	1279.70
.00028600	1284.22
.00028700	1288.74
.00028800	1293.26
.00028900	1297.78
.00029000	1302.31
.00029100	1306.83
.00029200	1311.35
.00029300	1315.88
.00029400	1320.40
.00029500	1324.92
.00029600	1329.45
.00029700	1333.97
.00029800	1338.50
.00029900	1343.02
.00030000	1347.55
.00030100	1352.07
.00030200	1356.60
.00030300	1361.12
.00030400	1365.65
.00030500	1370.18
.00030600	1374.70
.00030700	1379.23
.00030800	1383.76
.00030900	1388.28
.00031000	1392.81
.00031100	1397.34
.00031200	1401.86
.00031300	1406.39
.00031400	1410.92
.00031500	1415.45

RATIO K/N	RSPAN
.00031600	1419.98
.00031700	1424.50
.00031800	1429.03
.00031900	1433.56
.00032000	1438.09
.00032100	1442.62
.00032200	1447.15
.00032300	1451.68
.00032400	1456.21
.00032500	1460.74
.00032600	1465.27
.00032700	1469.80
.00032800	1474.33
.00032900	1478.86
.00033000	1483.39
.00033100	1487.93
.00033200	1492.46
.00033300	1496.99
.00033400	1501.52
.00033500	1506.05
.00033600	1510.59
.00033700	1515.12
.00033800	1519.65
.00033900	1524.18
.00034000	1528.72
.00034100	1533.25
.00034200	1537.79
.00034300	1542.32
.00034400	1546.85
.00034500	1551.39
.00034600	1555.92
.00034700	1560.46
.00034800	1564.99
.00034900	1569.53
.00035000	1574.06
.00035100	1578.60
.00035200	1583.13
.00035300	1587.67
.00035400	1592.21
.00035500	1596.74
.00035600	1601.28
.00035700	1605.81
.00035800	1610.35
.00035900	1614.89
.00036000	1619.43
.00036100	1623.96
.00036200	1628.50
.00036300	1633.04
.00036400	1637.58
.00036500	1642.12
.00036600	1646.65
.00036700	1651.19

FIGURE 7-1 (CONTINUED)

RATIO K/N	RSPAN	RATIO K/N	RSPAN	RATIO K/N	RSPAN	RATIO K/N	RSPAN
.00036800	1655.73	.00042000	1892.04	.00052400	2366.22	.00062800	2842.43
.00036900	1660.27	.00042200	1901.14	.00052600	2375.36	.00063000	2851.61
.00037000	1664.81	.00042400	1910.24	.00052800	2384.50	.00063200	2860.78
.00037100	1669.35	.000042600	1919.34	.00053000	2393.64	.00063400	2869.96
.00037200	1673.89	.00042800	1928.44	.00053200	2402.78	.00063600	2879.14
.00037300	1678.43	.00043000	1937.54	.00053400	2411.93	.00063800	2888.32
.00037400	1682.97	.00043200	1946.64	.00053600	2421.07	.00064000	2897.50
.00037500	1687.51	.00043400	1955.75	.00053800	2430.21	.00064200	2906.68
.00037600	1692.05	.00043600	1964.85	.00054000	2439.36	.00064400	2915.87
.00037700	1696.59	.00043800	1973.96	.00054200	2448.50	.00064600	2925.05
.00037800	1701.13	.00044000	1983.06	.00054400	2457.65	.00064800	2934.23
.00037900	1705.67	.00044200	1992.17	.00054600	2466.80	.00065000	2943.42
.00038000	1710.22	.00044400	2001.28	.00054800	2475.94	.00065200	2952.60
.00038100	1714.76	.00044600	2010.39	.00055000	2485.09	.00065400	2961.79
.00038200	1719.30	.00044800	2019.50	.00055200	2494.24	.00065600	2970.97
.00038300	1723.84	.00045000	2028.61	.00055400	2503.39	.00065800	2980.16
.00038400	1728.38	.00045200	2037.72	.00055600	2512.54	.00066000	2989.35
.00038500	1732.93	.00045400	2046.83	.00055800	2521.69	.00066200	2998.53
.00038600	1737.47	.00045600	2055.94	.00056000	2530.84	.00066400	3007.72
.00038700	1742.01	.00045800	2065.06	.00056200	2539.99	.00066600	3016.91
.00038800	1746.55	.00046000	2074.17	.00056400	2549.15	.00066800	3026.10
.00038900	1751.10	.00046200	2083.29	.00056600	2558.30	.00067000	3035.29
.00039000	1755.64	.00046400	2092.40	.00056800	2567.46	.00067200	3044.48
.00039100	1760.18	.00046600	2101.52	.00057000	2576.61	.00067400	3053.68
.00039200	1764.73	.00046800	2110.63	.00057200	2585.77	.00067600	3062.87
.00039300	1769.27	.00047000	2119.75	.00057400	2594.92	.00067800	3072.06
.00039400	1773.82	.00047200	2128.87	.00057600	2604.08	.00068000	3081.26
.00039500	1778.36	.00047400	2137.99	.00057800	2613.24	.00068200	3090.45
.00039600	1782.91	.00047600	2147.11	.00058000	2622.40	.00068400	3099.65
.00039700	1787.45	.00047800	2156.23	.00058200	2631.56	.00068600	3108.85
.00039800	1792.00	.00048000	2165.35	.00058400	2640.72	.00068800	3118.04
.00039900	1796.54	.00048200	2174.48	.00058600	2649.88	.00069000	3127.24
.00040000	1801.09	.00048400	2183.60	.00058800	2659.04	.00069200	3136.44
.00040100	1805.63	.00048600	2192.72	.00059000	2668.20	.00069400	3145.64
.00040200	1810.18	.00048800	2201.85	.00059200	2677.37	.00069600	3154.84
.00040300	1814.72	.00049000	2210.97	.00059400	2686.53	.00069800	3164.04
.00040400	1819.27	.00049200	2220.10	.00059600	2695.70	.00070000	3173.24
.00040500	1823.82	.00049400	2229.23	.00059800	2704.86	.00070200	3182.44
.00040600	1828.36	.00049600	2238.36	.00060000	2714.03	.00070400	3191.65
.00040700	1832.91	.00049800	2247.48	.00060200	2723.20	.00070600	3200.85
.00040800	1837.46	.00050000	2256.61	.00060400	2732.36	.00070800	3210.05
.00040900	1842.00	.00050200	2265.74	.00060600	2741.53	.00071000	3219.26
.00041000	1846.55	.00050400	2274.87	.00060800	2750.70	.00071200	3219.26
.00041100	1851.10	.00050600	2284.01	.00061000	2759.87	.00071400	3228.46
.00041200	1855.65	.00050800	2293.14	.00061200	2769.04	.00072000	3265.29
.00041300	1860.19	.00051000	2302.27	.00061400	2778.21	.00072200	3274.50
.00041400	1864.74	.00051200	2311.41	.00061600	2787.38	.00072400	3283.71
.00041500	1869.29	.00051400	2320.54	.00061800	2796.56	.00072600	3292.92
.00041600	1873.84	.00051600	2329.68	.00062000	2805.73	.00072800	3302.13
.00041700	1878.39	.00051800	2338.81	.00062200	2814.90	.00073000	3311.34
.00041800	1882.94	.00052000	2347.95	.00062400	2824.08	.00073200	3320.55
.00041900	1887.49	.00052200	2357.09	.00062600	2833.25	.0073400	3329.77

FIGURE 7-1 (CONTINUED)

RATIO K/N	RSPAN
.00073200	3320.55
.00073400	3329.77
.00073600	3338.98
.00073800	3348.19
.00074000	3357.41
.00074200	3366.63
.00074400	3375.84
.00074600	3385.06
.00074800	3394.28
.00075000	3403.49
.00075200	3412.71
.00075400	3421.93
.00075600	3431.15
.00075800	3440.37
.00076000	3449.60
.00076200	3458.82
.00076400	3468.04
.00076600	3477.26
.00076800	3486.49
.00077000	3495.71
.00077200	3495.71
.00077200	3504.94
.00077400	3514.17
.00077600	3523.39
.00077800	3532.62
.00078000	3541.85
.00078200	3551.08
.00078400	3560.31
.00078600	3569.54
.00078800	3578.77
.00079000	3588.00
.00079200	3597.23
.00079400	3606.46
.00079600	3615.70
.00079800	3624.93
.00080000	3634.17
.00080200	3643.40
.00080400	3652.64
.00080600	3661.87
.00080800	3671.11
.00081000	3680.35
.00081200	3689.59
.00081400	3698.83
.00081600	3708.07
.00081800	3717.31
.00082000	3726.55
.00082200	3735.79
.00082400	3745.03
.00082600	3754.28
.00082800	3763.52
.00083000	3772.77
.00083200	3782.01

RATIO K/N	RSPAN
.00083600	3800.50
.00083800	3809.75
.00084000	3819.00
.00084200	3828.25
.00084400	3837.50
.00084400	3837.50
.00084600	3846.75
.00084800	3856.00
.00085000	3865.25
.00085200	3874.50
.00085400	3883.75
.00085600	3893.00
.00085800	3902.26
.00086000	3911.51
.00086400	3930.02
.00086800	3948.53
.00087200	3967.05
.00087600	3985.57
.00088000	4004.09
.00088400	4022.61
.00088800	4041.14
.00089200	4059.66
.00089600	4078.20
.00090000	4096.73
.00090400	4115.26
.00090800	4133.80
.00091200	4152.34
.00091600	4170.89
.00092000	4189.43
.00092400	4207.98
.00092800	4226.53
.00093200	4245.08
.00093600	4263.64
.00094000	4282.20
.00094400	4300.76
.00094800	4319.32
.00095200	4337.88
.00095600	4356.45
.00096000	4375.02
.00096400	4393.59
.00096800	4412.17
.00097200	4430.75
.00097600	4449.33
.00098000	4467.91
.00098400	4486.49
.00098800	4505.08
.00099200	4523.67
.00099600	4542.26
.00100000	4560.86
.00100400	4579.45
.00100800	4598.05
.00101200	4616.65

RATIO K/N	RSPAN
.00102000	4653.86
.00102400	4672.47
.00102800	4691.08
.00103200	4709.70
.00103600	4728.31
.00103600	4728.31
.00104000	4746.93
.00104400	4765.55
.00104800	4784.17
.00105200	4802.80
.00105600	4821.43
.00106000	4840.06
.00106400	4858.69
.00106800	4877.32
.00107200	4895.96
.00107600	4914.60
.00108000	4933.24
.00108400	4951.88
.00108800	4970.53
.00109200	4989.18
.00109600	5007.83
.00110000	5026.48
.00110500	5049.80
.00111000	5073.13
.00111500	5096.45
.00112000	5119.78
.00112500	5143.12
.00113000	5166.45
.00113500	5189.80
.00114000	5213.14
.00114500	5236.49
.00115000	5259.84
.00115500	5283.20
.00116000	5306.55
.00116500	5329.92
.00117000	5353.28
.00117500	5376.65
.00118000	5400.03
.00118500	5423.40
.00119000	5446.78
.00119500	5470.16
.00120000	5493.55
.00120500	5516.94
.00121000	5540.33
.00121500	5563.73
.00122000	5587.13
.00122500	5610.54
.00123000	5633.94
.00123500	5667.35
.00124000	5680.77
.00124500	5704.19
.00125000	5727.61

RATIO K/N	RSPAN
.00126000	5774.46
.00126500	5797.89
.00127000	5821.33
.00127500	5844.76
.00128000	5868.20
.00128000	5868.20
.00128500	5891.65
.00129000	5915.10
.00129500	5938.55
.00130000	5962.00
.00130500	5985.46
.00131000	6008.92
.00131500	6032.39
.00132000	6055.86
.00132500	6079.33
.00133000	6102.80
.00133500	6126.28
.00134000	6149.76
.00134500	6173.25
.00135000	6196.73
.00135500	6220.22
.00136000	6243.72
.00136500	6267.22
.00137000	6290.72
.00137500	6314.22
.00138000	6337.73
.00138500	6361.24
.00139000	6384.75
.00139500	6408.27
.00140000	6431.79
.00140500	6455.31
.00141000	6478.84
.00141500	6502.37
.00142000	6525.90
.00142500	6549.44
.00143000	6572.98
.00143500	6596.52
.00144000	6620.07
.00144500	6643.62
.00145000	6667.17
.00145500	6690.72
.00146000	6714.28
.00146500	6737.84
.00147000	6761.41
.00147500	6784.98
.00148000	6808.55
.00148500	6832.12
.00149000	6855.70
.00149500	6879.28
.00150000	6902.86
.00150500	6926.45
.00151000	6950.04

FIGURE 7-1 (CONTINUED)

RATIO K/N	RSPAN
.00152000	6997.23
.00152500	7020.83
.00153000	7044.43
.00153500	7068.03
.00154000	7091.64
.00154500	7115.25
.00155000	7138.87
.00155500	7162.48
.00156000	7186.11
.00156500	7209.73
.00157000	7233.36
.00157500	7256.98
.00158000	7280.62
.00158500	7304.25
.00159000	7327.89
.00159500	7351.53
.00160000	7375.18
.00160500	7398.83
.00161000	7422.48
.00161500	7446.13
.00162000	7469.79
.00162500	7493.45
.00163000	7517.11
.00163500	7540.77
.00164000	7564.44
.00164500	7588.11
.00165000	7611.79
.00165500	7635.47
.00166000	7659.15
.00166500	7682.83
.00167000	7706.52
.00167500	7730.20
.0016800	7753.90
.00168500	7777.59
.00169000	7801.29
.00169500	7824.99
.00170000	7848.69
.00170500	7872.40
.00171000	7896.11
.00171500	7919.82
.00172000	7943.54
.00172500	7967.26
.00173000	7990.98
.00173500	8014.70
.00174000	8038.43
.00174500	8062.16
.00175000	8085.89
.00175500	8109.63
.00176000	8133.37
.00176500	8157.11
.00177000	8180.85
.00177500	8204.60

RATIO K/N	RSPAN
.00178000	8228.35
.00178500	8252.10
.00179000	8275.86
.00179500	8299.62
.00180000	8323.38
.00180500	8347.14
.00181000	8370.91
.00181500	8394.68
.00182000	8418.45
.00182500	8442.22
.00183000	8466.00
.00183500	8489.78
.00184000	8513.57
.00184500	8537.35
.00185000	8561.14
.00185500	8584.93
.00186000	8608.73
.00186500	8632.53
.00187000	8656.33
.00187500	8680.13
.00188000	8703.94
.00188500	8727.75
.00189000	8751.56
.00189500	8775.37
.00190000	8799.19
.00190500	8823.01
.00191000	8846.83
.00191500	8870.65
.00192000	8894.48
.00192500	8918.31
.00193000	8942.15
.00193500	8965.98
.00194000	8989.82
.00194500	9013.66
.00195000	9037.51
.00195500	9061.35
.00196000	9085.20
.00196500	9109.06
.00197000	9132.91
.00197500	9156.77
.00198000	9180.63
.00198500	9204.49
.00199000	9228.36
.00199500	9252.23
.00200000	9276.10
.00200500	9299.97
.00201000	9323.85
.00201500	9347.73
.00202000	9371.61
.00202500	9395.49
.00203000	9419.38
.00203500	9443.27

RATIO K/N	RSPAN
.00204000	9467.16
.00204500	9491.05
.00205000	9514.95
.00205500	9538.85
.00206000	9562.76
.00206500	9586.66
.00207000	9610.57
.00207500	9634.48
.00208000	9658.39
.00208500	9682.31
.00209000	9706.23
.00209500	9730.15
.00210000	9754.07
.00211000	9801.93
.00212000	9849.79
.00213000	9897.67
.00214000	9945.55
.00215000	9993.45
.00216000	10041.36
.00217000	10089.27
.00218000	10137.20
.00219000	10185.14
.00220000	10233.09
.00221000	10281.04
.00222000	10329.01
.00223000	10376.99
.00224000	10424.98
.00225000	10472.98
.00226000	10520.98
.00227000	10569.00
.00228000	10617.03
.00229000	10665.07
.00230000	10713.11
.00231000	10761.17
.00232000	10809.24
.00233000	10857.32
.00234000	10905.40
.00235000	10953.50
.00236000	11001.61
.00237000	11049.72
.00238000	11097.85
.00239000	11145.99
.00240000	11194.13
.00241000	11242.29
.00242000	11290.45
.00243000	11338.63
.00244000	11386.81
.00245000	11435.00
.00246000	11483.21
.00247000	11531.42
.00248000	11579.64
.00249000	11627.87

RATION K/N	RSPAN
.00250000	11676.11
.00251000	11724.36
.00252000	11772.62
.00253000	11820.89
.00254000	11869.17
.00255000	11917.46
.00256000	11965.76
.00257000	12014.07
.00258000	12062.38
.00259000	12110.71
.00260000	12159.04
.00261000	12207.39
.00262000	12255.74
.00263000	12304.10
.00264000	12352.47
.00265000	12400.85
.00266000	12449.24
.00267000	12497.64
.00268000	12546.05
.00269000	12594.47
.00270000	12642.89
.00271000	12691.33
.00272000	12739.77
.00273000	12788.23
.00274000	12836.69
.00275000	12885.16
.00276000	12933.64
.00277000	12982.13
.00278000	13030.63
.00279000	13079.14
.00280000	13127.65
.00281000	13176.18
.00282000	13224.71
.00283000	13273.26
.00284000	13321.81
.00285000	13370.37
.00286000	13418.94
.00287000	13467.52
.00288000	13516.10
.00289000	13564.70
.00290000	13613.30
.00291000	13661.92
.00292000	13710.54
.00293000	13759.17
.00294000	13807.81
.00295000	13856.46
.00296000	13905.11
.00297000	13953.78
.00298000	14002.45
.00299000	14051.14
.00300000	14099.83
.00301000	14148.53

FIGURE 7-1 (CONTINUED)

RATIO K/N	RSPAN
.00302000	14197.23
.00303000	14245.95
.00304000	14294.68
.00305000	14343.41
.00306000	14392.15
.00307000	14440.90
.00308000	14489.66
.00309000	14538.43
.00310000	14587.21
.00311000	14635.99
.00312000	14684.79
.00313000	14733.59
.00314000	14782.40
.00315000	14831.21
.00316000	14880.04
.00317000	14928.88
.00318000	14977.72
.00319000	15026.57
.00320000	15075.43
.00321000	15124.30
.00322000	15173.18
.00323000	15222.06
.00324000	15270.95
.00325000	15319.86
.00326000	15368.77
.00327000	15417.68
.00328000	15466.61
.00329000	15515.54
.00330000	15564.49
.00331000	15613.44
.00332000	15662.40
.00333000	15711.36
.00334000	15760.34
.00335000	15809.32
.00336000	15858.31
.00337000	15907.31
.00338000	15956.32
.00339000	16005.34
.00340000	16054.36
.00341000	16103.39
.00342000	16152.43
.00343000	16201.48
.00344000	16250.54
.00345000	16299.60
.00346000	16348.67
.00347000	16397.75
.00348000	16446.84
.00349000	16495.94
.00350000	16545.04
.00351000	16594.15
.00352000	16643.27
.00353000	16692.40

RATIO K/N	RSPAN
.00354000	16741.54
.00355000	16790.68
.00356000	16839.83
.00357000	16888.99
.00358000	16938.16
.00359000	16987.33
.00360000	17036.52
.00361000	17085.71
.00362000	17134.90
.00363000	17184.11
.00364000	17233.33
.00365000	17282.55
.00366000	17331.78
.00367000	17381.02
.00368000	17430.26
.00369000	17479.51
.00370000	17528.78
.00371000	17578.04
.00372000	17627.32
.00373000	17676.60
.00374000	17725.90
.00375000	17775.20
.00376000	17824.50
.00377000	17873.82
.00378000	17923.14
.00379000	17972.47
.00380000	18021.81
.00381000	18071.16
.00382000	18120.51
.00383000	18169.87
.00384000	18219.24
.00385000	18268.62
.00386000	18318.00
.00387000	18367.39
.00388000	18416.79
.00389000	18466.20
.00390000	18515.61
.00391000	18565.03
.00392000	18614.46
.00393000	18663.90
.00394000	18713.34
.00395000	18762.80
.00396000	18812.26
.00397000	18861.72
.00398000	18911.20
.00399000	18960.68
.00400000	19010.17
.00401000	19059.67
.00402000	19109.17
.00403000	19158.68
.00404000	19208.20
.00405000	19257.73

RATIO K/N	RSPAN
.00406000	19307.27
.00407000	19356.81
.00408000	19406.36
.00409000	19455.91
.00410000	19505.48
.00411000	19555.05
.00412000	19604.63
.00413000	19654.22
.00414000	19703.81
.00415000	19753.41
.00416000	19803.02
.00417000	19852.64
.00418000	19902.26
.00419000	19951.89
.00420000	20001.53
.00422000	20100.83
.00424000	20200.15
.00426000	20299.51
.00428000	20398.90
.00430000	20498.31
.00432000	20597.76
.00434000	20697.23
.00436000	20796.73
.00438000	20896.26
.00440000	20995.82
.00442000	21095.41
.00444000	21195.03
.00446000	21294.68
.00448000	21394.35
.00450000	21494.06
.00452000	21593.79
.00454000	21693.55
.00456000	21793.34
.00458000	21893.16
.00460000	21993.00
.00462000	22092.88
.00464000	22192.78
.00466000	22292.71
.00468000	22392.67
.00470000	22492.66
.00472000	22592.68
.00474000	22692.72
.00476000	22792.79
.00478000	22892.89
.00480000	22993.02
.00482000	23093.18
.00484000	23193.36
.00486000	23293.57
.00488000	23393.81
.00490000	23494.08
.00492000	23594.38
.00494000	23694.70

RATIO K/N	RSPAN
.00496000	23795.05
.00498000	23895.43
.00500000	23995.84
.00606000	29356.09
.00608000	29457.94
.00506000	24297.22
.00508000	24397.74
.00510000	24498.28
.00512000	24598.85
.00514000	24699.45
.00516000	24800.08
.00518000	24900.73
.00520000	25001.41
.00522000	25102.12
.00524000	25202.85
.00526000	25303.62
.00528000	25404.41
.00530000	25505.22
.00532000	25606.07
.00534000	25706.94
.00536000	25807.83
.00538000	25908.76
.00540000	26009.71
.00542000	26110.69
.00544000	26211.69
.00546000	26312.73
.00548000	26413.79
.00550000	26514.87
.00552000	26615.99
.00554000	26717.13
.00556000	26818.29
.00558000	26919.49
.00560000	27020.71
.00562000	27121.95
.00564000	27223.23
.00566000	27324.53
.00568000	27425.85
.00570000	27527.21
.00572000	27628.59
.00574000	27729.99
.00576000	27831.43
.00578000	27932.89
.00580000	28034.37
.00582000	28135.88
.00584000	28237.42
.00586000	28338.99
.00588000	28440.58
.00590000	28542.20
.00592000	28643.84
.00594000	28745.51
.00596000	28847.21
.00598000	28948.93

FIGURE 7-1 (CONTINUED)

RATIO K/N	RSPAN
.00600000	29050.68
.00602000	29152.46
.00604000	29254.26
.00606000	29356.09
.00608000	29457.94
.00610000	29559.83
.00612000	29661.73
.00614000	29763.67
.00616000	29865.62
.00618000	29967.61
.00620000	30069.62
.00622000	30171.66
.00624000	30273.72
.00626000	30375.81
.00628000	30477.93
.00630000	30580.07
.00632000	30682.24
.00634000	30784.43
.00636000	30886.65
.00638000	30988.89
.00640000	31091.17
.00642000	31193.46
.00644000	31295.79
.00646000	31398.13
.00648000	31500.51
.00650000	31602.91
.00652000	31705.34
.00654000	31807.79
.00656000	31910.27
.00658000	32012.77
.00660000	32115.30
.00662000	32217.96
.00664000	32320.44
.00666000	32423.04
.00668000	32525.68
.00670000	32628.33
.00672000	32731.02
00674000	32833.73
.00676000	32936.46
.00678000	33039.22
.00680000	33142.01
.00682000	33244.82
.00684000	33347.66
.00686000	33450.52
.00688000	33553.41
.00690000	33656.33
.00692000	33759.27
.00694000	33862.23
.00696000	33965.23
.00698000	34068.24
.00700000	34171.29
.00702000	34274.35

RATIO K/N	RSPAN
.00704000	34377.45
.00706000	34480.57
.00708000	34583.71
.00710000	34686.88
.00712000	34790.08
.00714000	34893.30
.00716000	34996.54
.00718000	35099.81
.00720000	35203.11
.00722000	35306.43
.00724000	35409.78
.00726000	35513.16
.00728000	35616.55
.00730000	35719.98
.00732000	35823.43
.00734000	35926.90
.00736000	36030.40
.00738000	36133.93
.00740000	36237.48
.00742000	36341.06
.00744000	36444.66
.00746000	36548.29
.00748000	36651.94
.00750000	36755.62
.00752000	36859.32
.00754000	36963.05
.00756000	37066.80
.00758000	37170.58
.00760000	37274.38
.00762000	37378.21
.00764000	37482.07
.00766000	37585.95
.00768000	37689.85
.00770000	37793.78
.00772000	37897.74
.00774000	38001.72
.00776000	38105.72
.00778000	38209.76
.00780000	38313.81
.00782000	38417.89
.00784000	38522.00
.00786000	38626.13
.00788000	38730.29
.00790000	38834.47
.00792000	38938.68
.00794000	39042.91
.00796000	39147.17
.00798000	39251.45
.00800000	39355.76

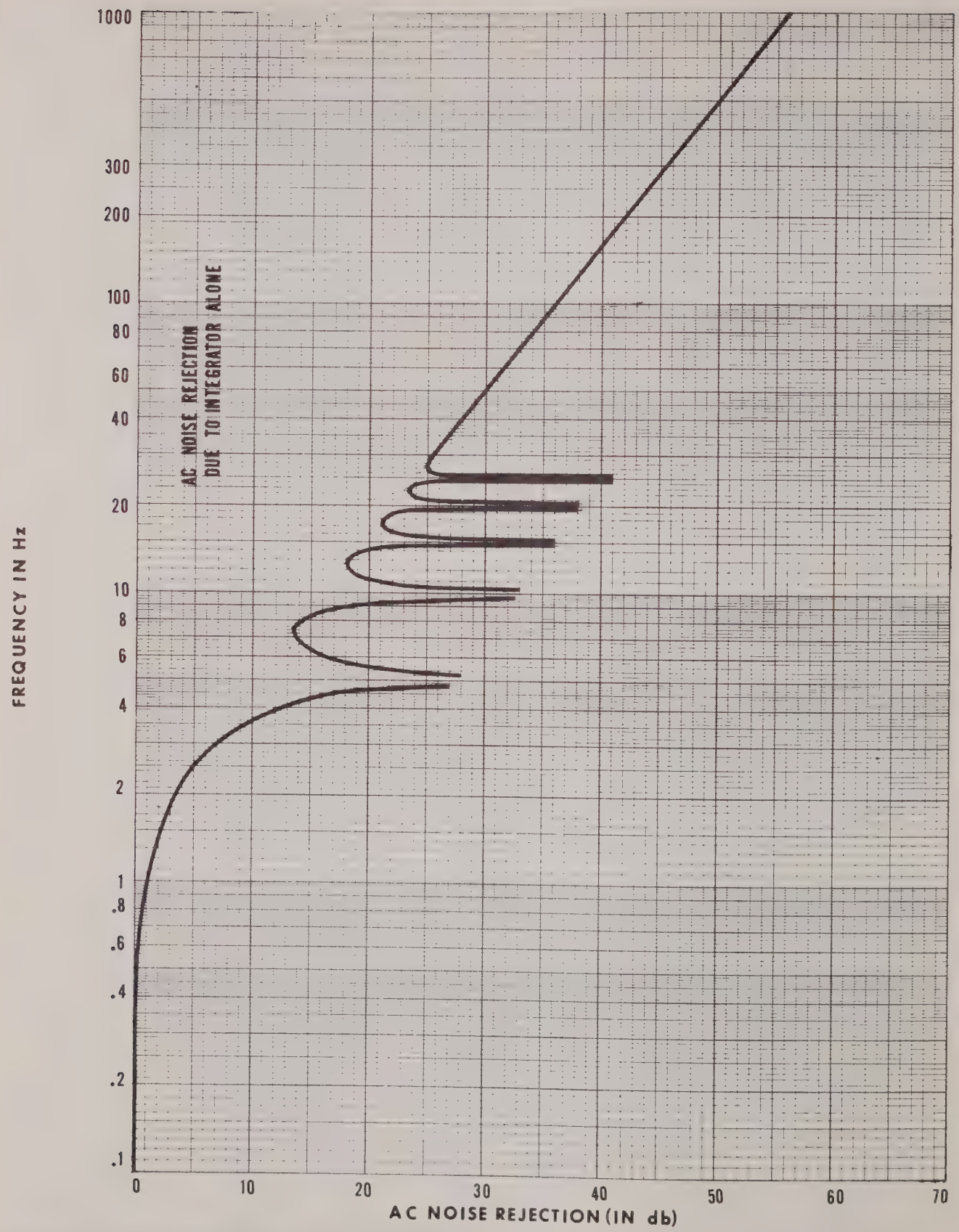


FIGURE 7-2. AC NOISE REJECTION DUE TO INTEGRATOR

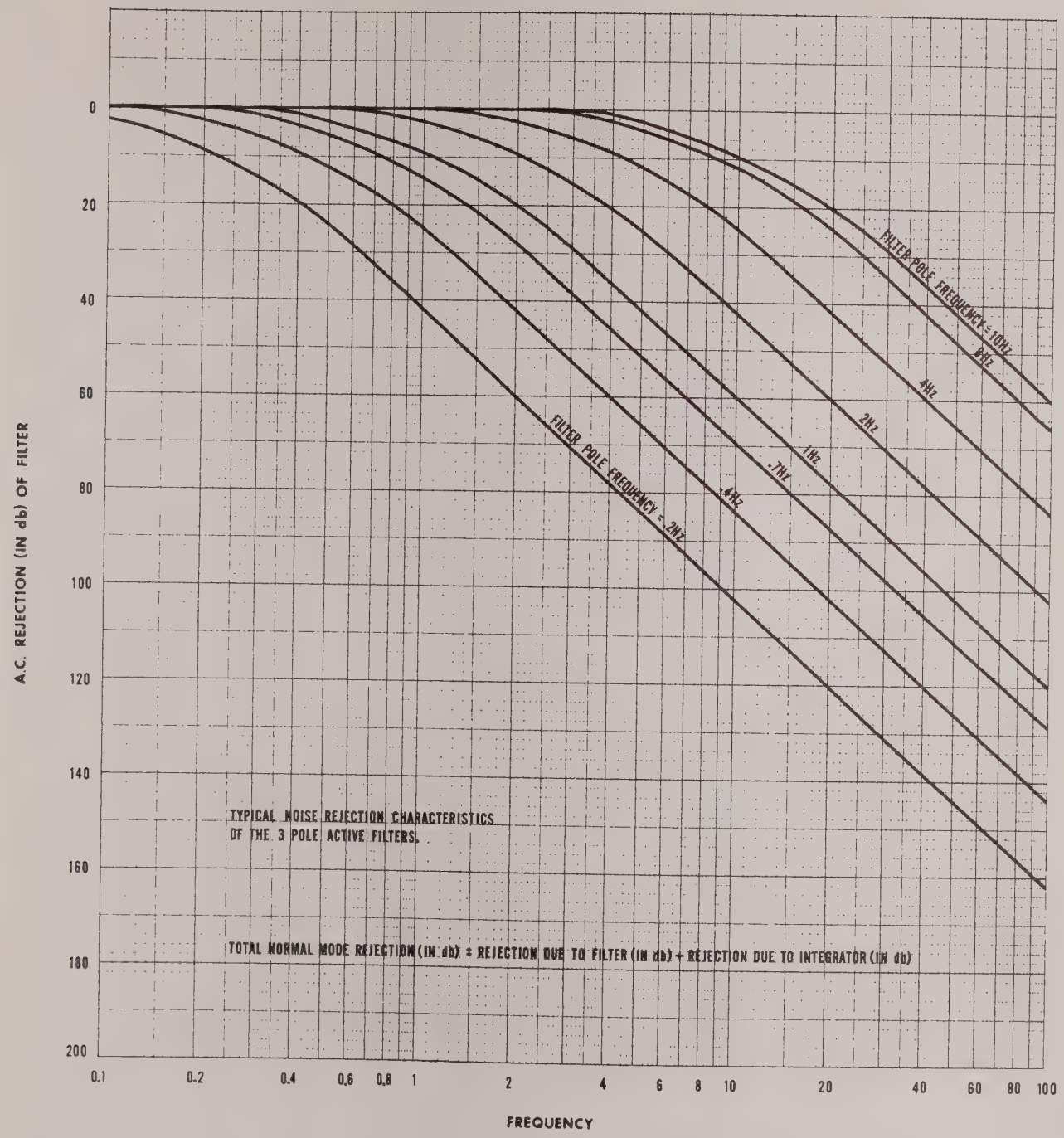


FIGURE 7-3. AC REJECTION OF FILTER

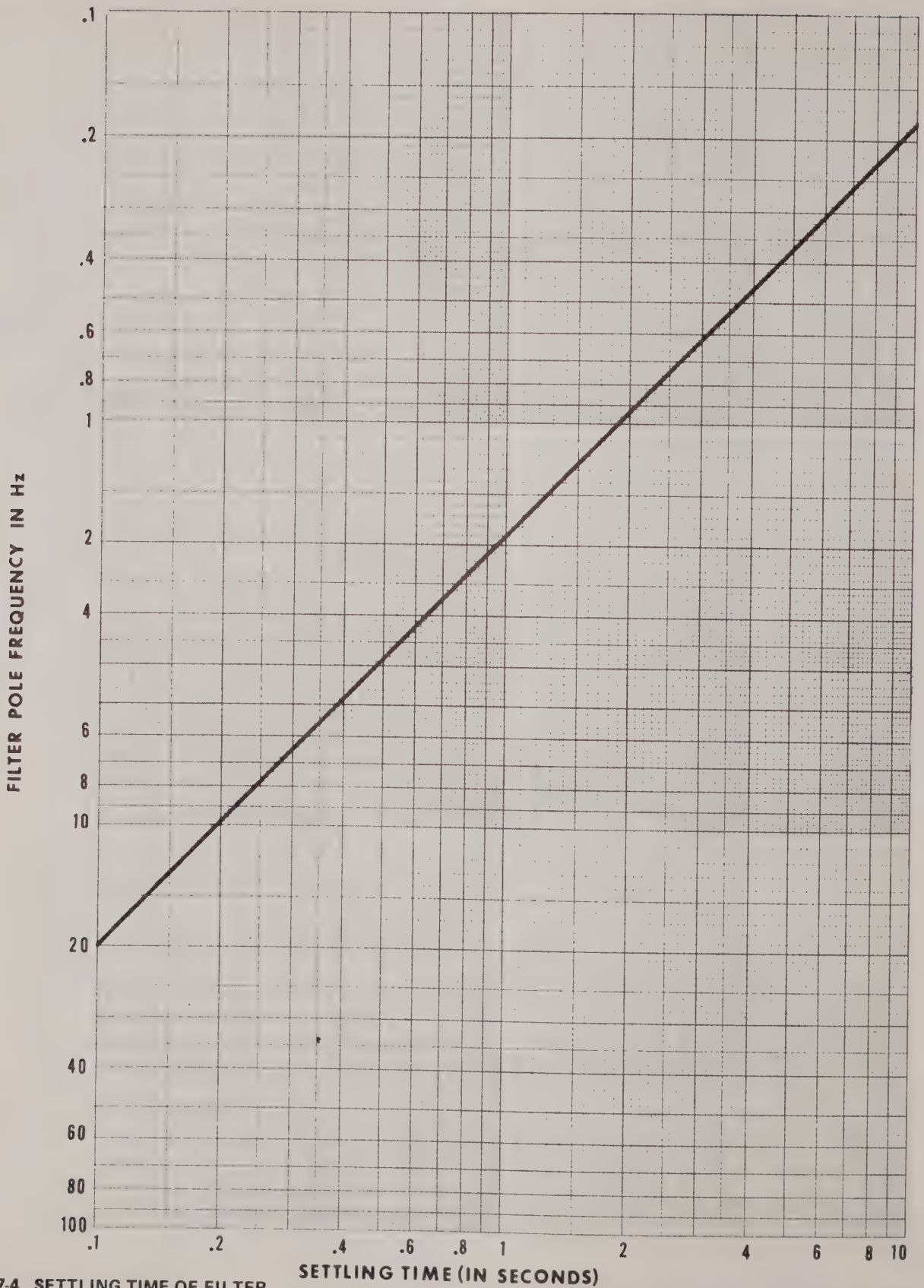


FIGURE 7-4. SETTLING TIME OF FILTER

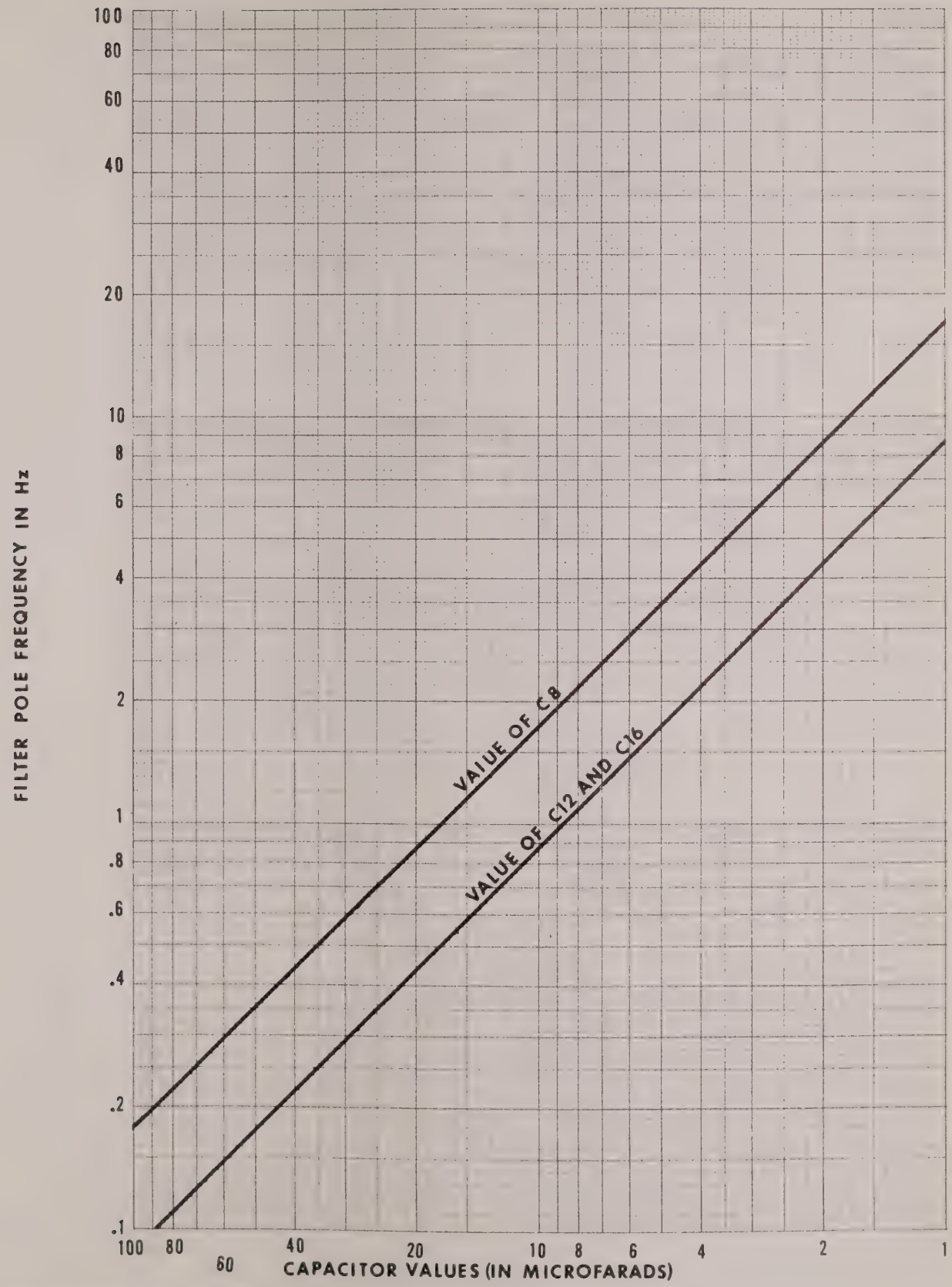
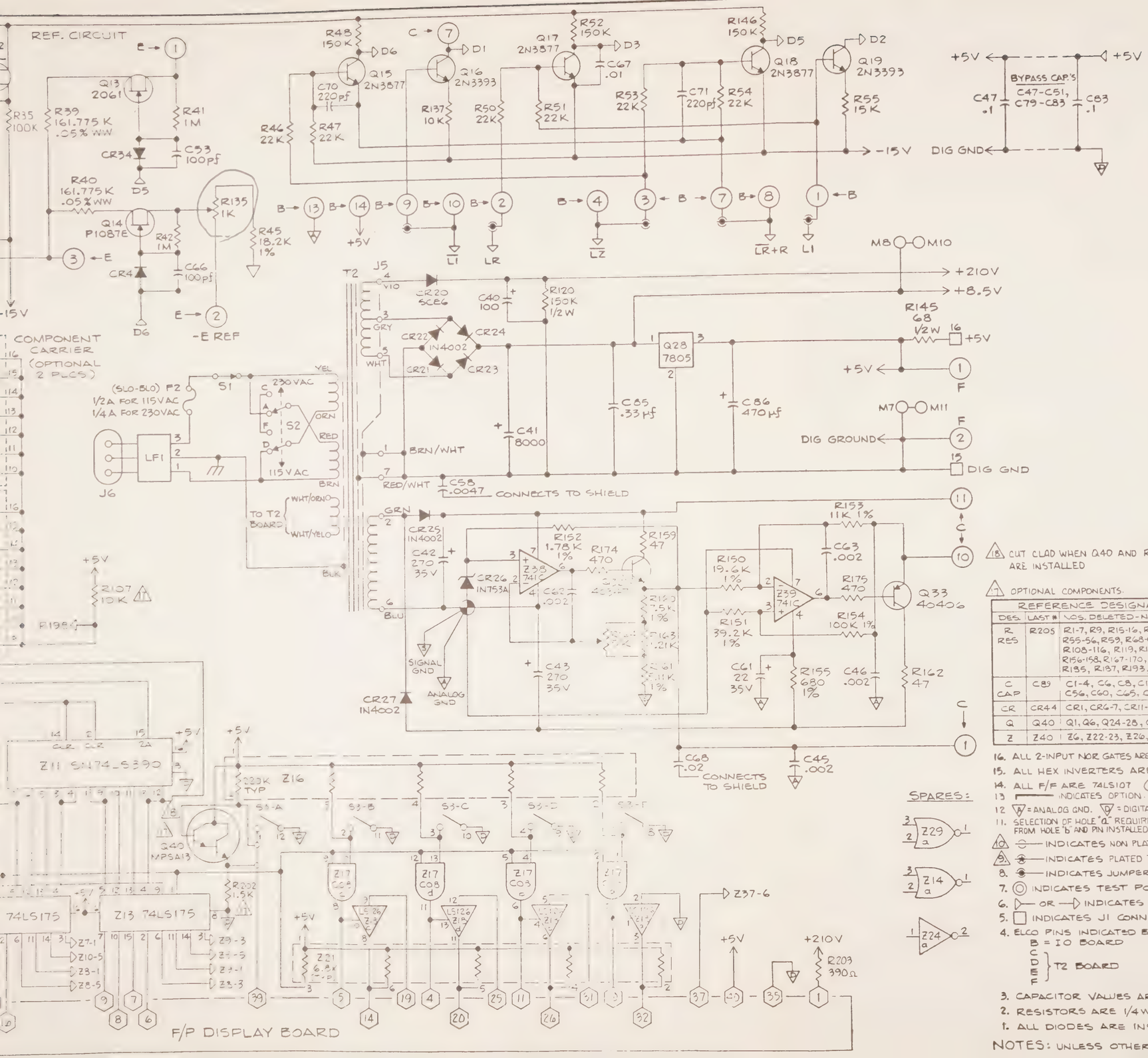
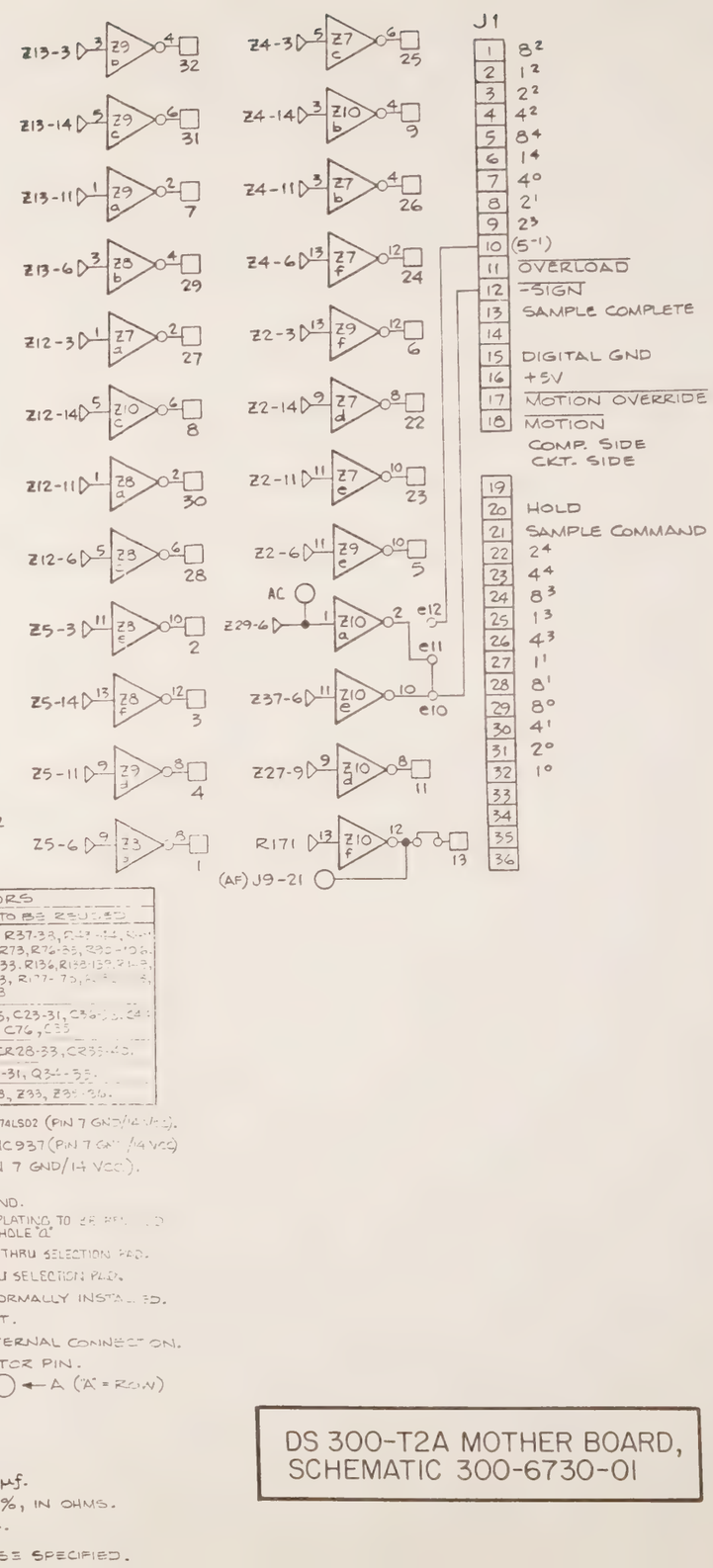


FIGURE 7-5. CAPACITOR VALUES

POWER OR ANALOG GND
SIGNAL GND
HI2 HI1
R179 1K
Q2 U1742 L.L.
Q3 U1742 L.L.
R8 39K
R10 47K
C5 220pf
D1
D2
+15V
Q4 FD1648
R17 165K 1%
R18 165K 1%
R19 249K 1%
R143 2.49K 1%
C54 470pf
R13 10K 1%
R14 10K 1%
R12 1K 1%
R11 5K
Q5 TP710
Q7 Q8 2N4250
R142 82.5K 1%
R141 20K 1%
R148 1K
C59 4.7μf 35V
C7 .068μf
C55 .22μf
R144 5.11K 1%
R20 100K 1%
R21 100K 1%
C9 .01
R23 1K
Z40 741
-15V
C10 .1μf
ZERO CROSSING CIRCUIT
CR2
Q9 2N3638
Q10 2N4250
R24 4.7K
R25 15K
R27 22Ω
R28 6.2K
R29 1K
C11 .01μf
CR3
D3
AUTO ZERO CIRCUIT
R31 220K
R30 68K
R32 1M
Q11 U1742 L.L.
R33 680K
R34 220K
C12 100
C13 .22
R36 10M
R26 16.2K 1%
D4
CLK
40KHZ (Z30-12)
20KHZ
RESET 1
741S74
Z31
Z32
RESET 3
R171 390
C69 .002μf
SC (Z10-13)
LO TO R61
80 K HZ
+5V
R165 100Ω
400 KHZ CLOCK
C64 .01μf
R58 10K
Q20 2N3415
CR5
C15 DM 15pf
R60 390Ω
Z24
935
PIN 14 = Vcc
PIN 7 = GND
R134 10K
400KHZ
R180 47K
R181 4.7K
C72 .005μf
C73 .001μf
NN (Z15-9)
C89 .001
Z34
R117 4.7K
Z29
Z37
LZ
M14
R118 4.7K
C39 .001
LR+R
J12
CONN. ON MOTION DETECTOR BOARD
1 Z30-6 (M1)
2 NO CONNECTION
3 Z14-9 (M5)
4 Z15-1 (M4)
5 NO CONNECTION
6 M16 (8) F
7 DIG GND (M7)
8 +8.5 (M8)
9 Z11-15 (M9)
10 +8.5 (M10)
11 DIG GND (M11)
12 Z20-1 (M17)
13 Z30-3 (M13)
14 Z37-3 (M14)
15 J1-18 (M15)
16 J1-17 (M16)
J9 CONNECTOR T2 REAR PANEL
1 Z34-2 (PP)
2 Z1-2 (RR)
3 Z10-1 (AC)
4 DIG GND (GG)
5 LL (13) F
6 R166 (H-H)
7 NO CONNECTION
8 AA (7) F
9 Z30-6 (QQ)
10 Z30-3 (TT)
11 Z11-15 (MM)
12 Z19-1 (JJ)
13 KK (10) F
14 BB (8) F
15 Z30-2 (SS)
16 DIG GND (GG)
17 DIG GND (GG)
18 DIG GND (GG)
19 DIG GND (GG)
20 NO CONNECTION
21 Z10-12 (AF)
22 NO CONNECTION
23 NO CONNECTION
24 Z15-4 (NN)
Z25
Z1-3
Z1-12
Z1-5
Z1-6
Z1-10
Z1-11
Z1-15
Z24
Z3-12
Z3-11
Z3-10
Z3-1
Z3-3
Z3-7
Z3-6
Z3-5
POLARITY F/F
Z24
Z37
Z10-11
40KHZ
L1
GATED CLOCK
Z29
e7 e8 e9
Z27-6
Z10-1
Z27-11
R176 470
CR43
Z20-10
LZ & DUAL DIFF.
M3
Z14
C19 .001
C20 .001
CR8
CR9
LZ
R70 4.7K
R71 4.7K
D4
LO
Z19
LR
Z15
R147 390
C57 .002
Z20
R204 1K
R186 470K
C75 .001
CR41
M4
LR
TP1
NN
F
3
C34 .001
R89 1.5K
TP2
R75 1.5K
R172 680
C22 .001
8000 BIT (Z1-1)
L1 (Z19-9)
JJ
L1
LR
C32 .001
C33 .001
R86 1.5K
R87 1.5K
Z14
R140 100
C52 .001
RESET 1
RESET GENERATOR
20KHZ
Z30
M1
Q2
RESET 2
RESET 3
M13
TT
6
KK
10
ΔLR
SS
RR
40KHZ (Z31-3)
RESET 2 (Z30-6)
R201 22
R184 1.0M
C84 10μf 20V
R195 169K 1%
R188 470K
R190 4.7K
R192 4.7K
C77
R194 100
CR42
CR44
Q38 2N3415
Q36 MPSA13
R191 1M
Z34-1 Z20-2
Q37 2N3415
R196 1M
R200 470K
R198 470K
Z25-16
Q39 2N3415
R199 470K
R205 220K
TO DIGITAL GND.
DISPLAY COUNTER INPUT
M17
e13
e3
e2 e1
MM
M9
LL
Z1 SN74LS390
Z3 SN74LS390
8000 BIT (R172)
Z25-1
Z25-3
Z25-4
Z25-2
Z25-5
Z25-6
Z41-1
Z41-2
Z41-3
Z41-4
Z41-5
Z41-8
Z41-7
Z41-6
Z27 74LS74
e4 e5 e6 e9
Z10-9
Z2 74LS175
Z4 74LS175
Z5 74LS175
Z9-13
Z7-9
Z9-11
Z7-5
Z10-3
Z7-3
Z7-13
Z9-5
Z8-5
SAMPLE RATE GENERATOR
SAMPLE COMMAND
C16 .01
R63 1K
R64 10K
C17 .001
CR10
RESET 2 (Z30-6)
HH
R166 4.7K
R61 4.7K
LO Z32-6
HOLD 20
R62 4.7K
C21 22
R72 22K
R65 1K
R66 24K
C18 .001
TP5
Q22 2N4250
Q21 2N3393
Q23 2N 3393
R74 2.2K
+5V
20KHZ
TP4
LO
Z19
LI (Z14-9)
LR
C88 .001
D4
Z24
R184 1.0M
R195 169K 1%
C84 10μf 20V
R188 470K
R190 4.7K
C77
R194 100
CR42
CR44
Q38 2N3415
Q36 MPSA13
R191 1M
Z34-1 Z20-2
Q37 2N3415
R196 1M
R200 470K
R198 470K
Z25-16
Q39 2N3415
R199 470K
R205 220K
TO DIGITAL GND.





18 CUT CLAD WHEN Q40 AND R202 ARE INSTALLED

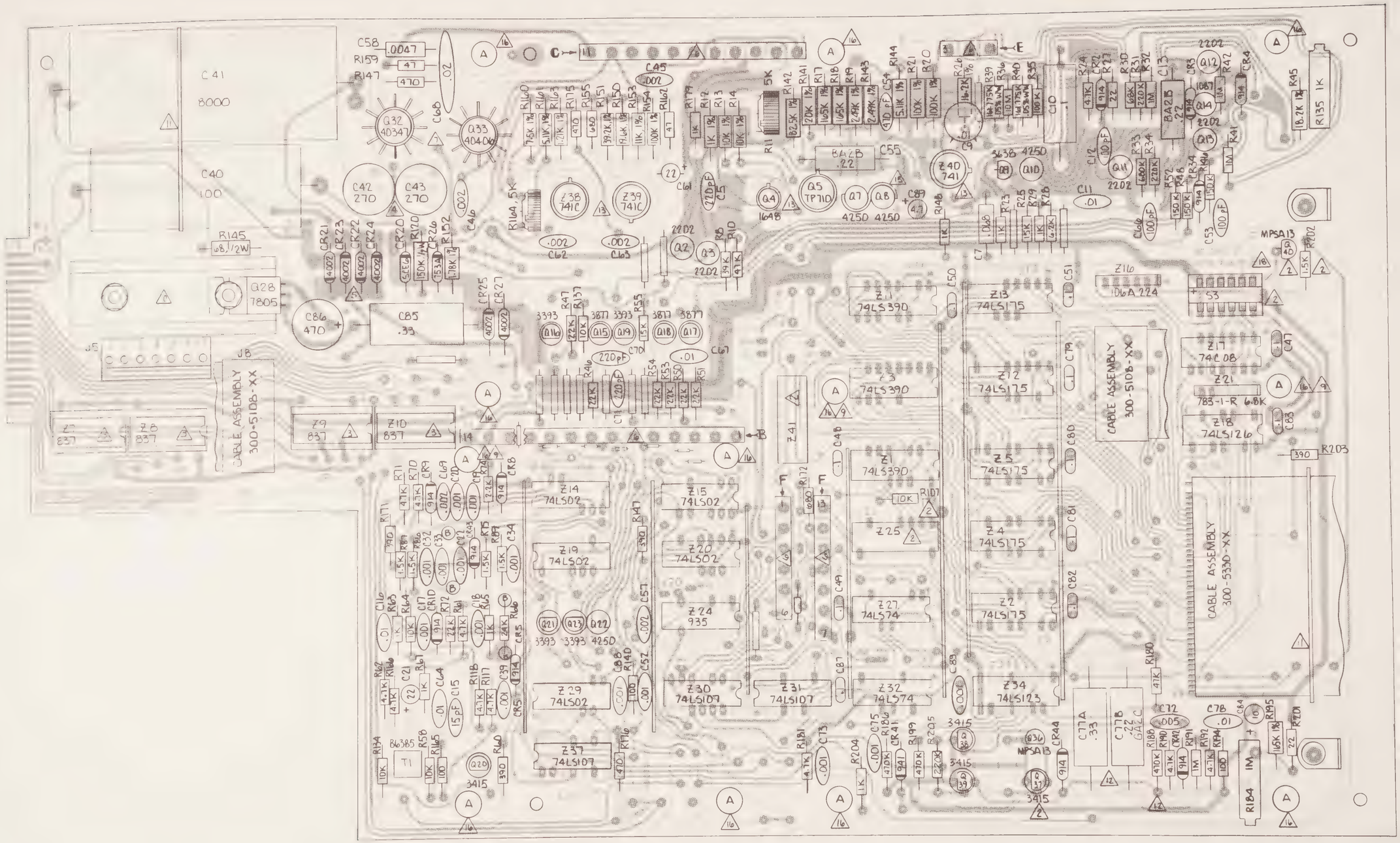
1 OPTIONAL COMPONENTS.

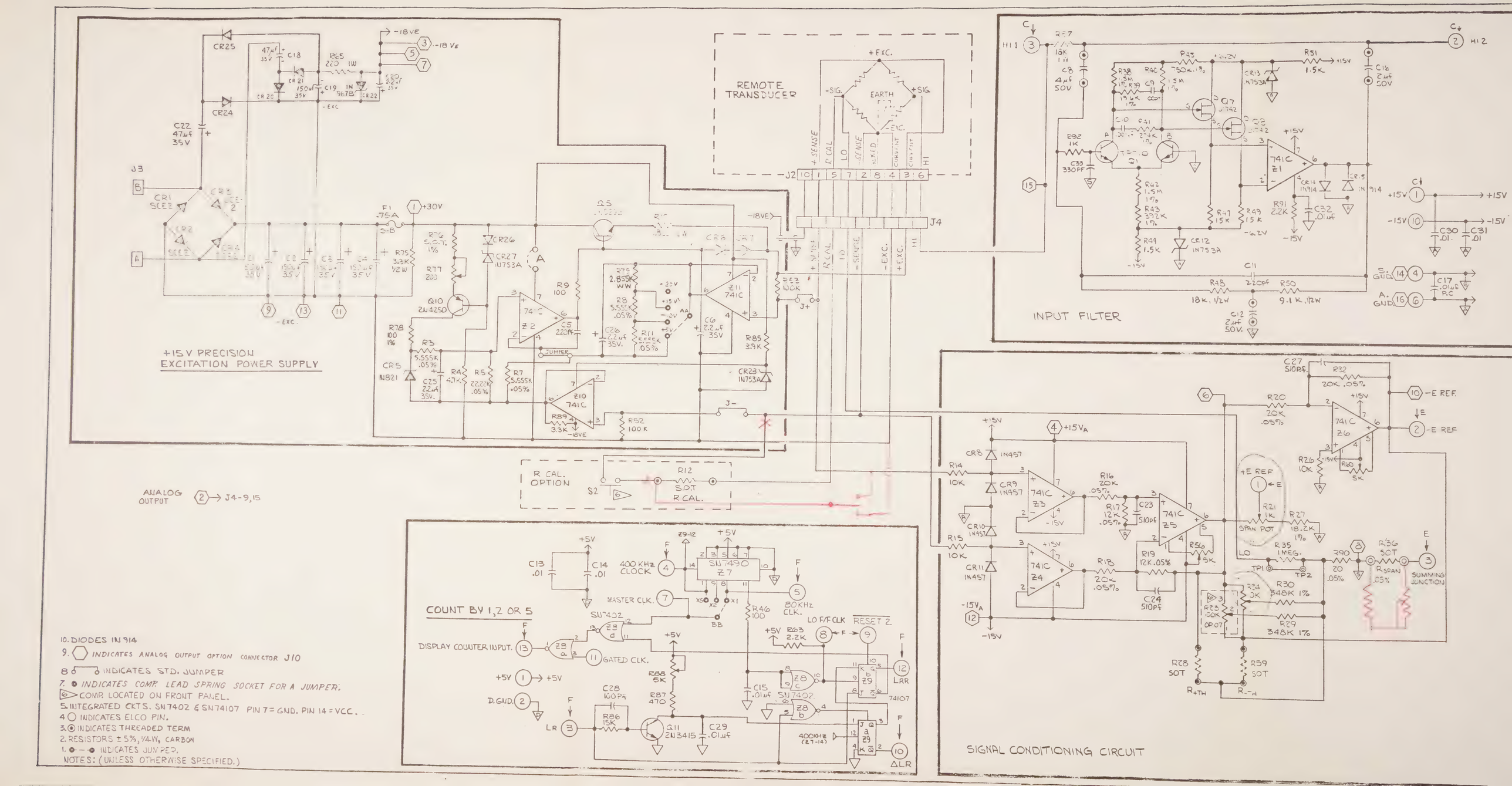
REFERENCE DESIGNATORS		
DES	LAST #	NOS. DELETED-NOT TO BE REUSED
R RES	R205	R1-7, R9, R15-16, R22, R37-38, R43-44, R54-55, R55-56, R59, R68-69, R73, R76-85, R95-103, R108-116, R119, R121-133, R136, R152-153, R156-158, R167-170, R173, R177-180, R183-184, R185, R187, R193, R88
C CAP	C89	C1-4, C6, C8, C14-15, C23-31, C36-39, C42, C56, C60, C65, C74, C76, C88
CR	CR44	CR1, CR6-7, CR11-19, CR28-33, CR35-40.
Q	Q40	Q1, Q6, Q24-28, Q30-31, Q34-35.
Z	Z40	Z6, Z22-23, Z26, Z28, Z33, Z34-36.

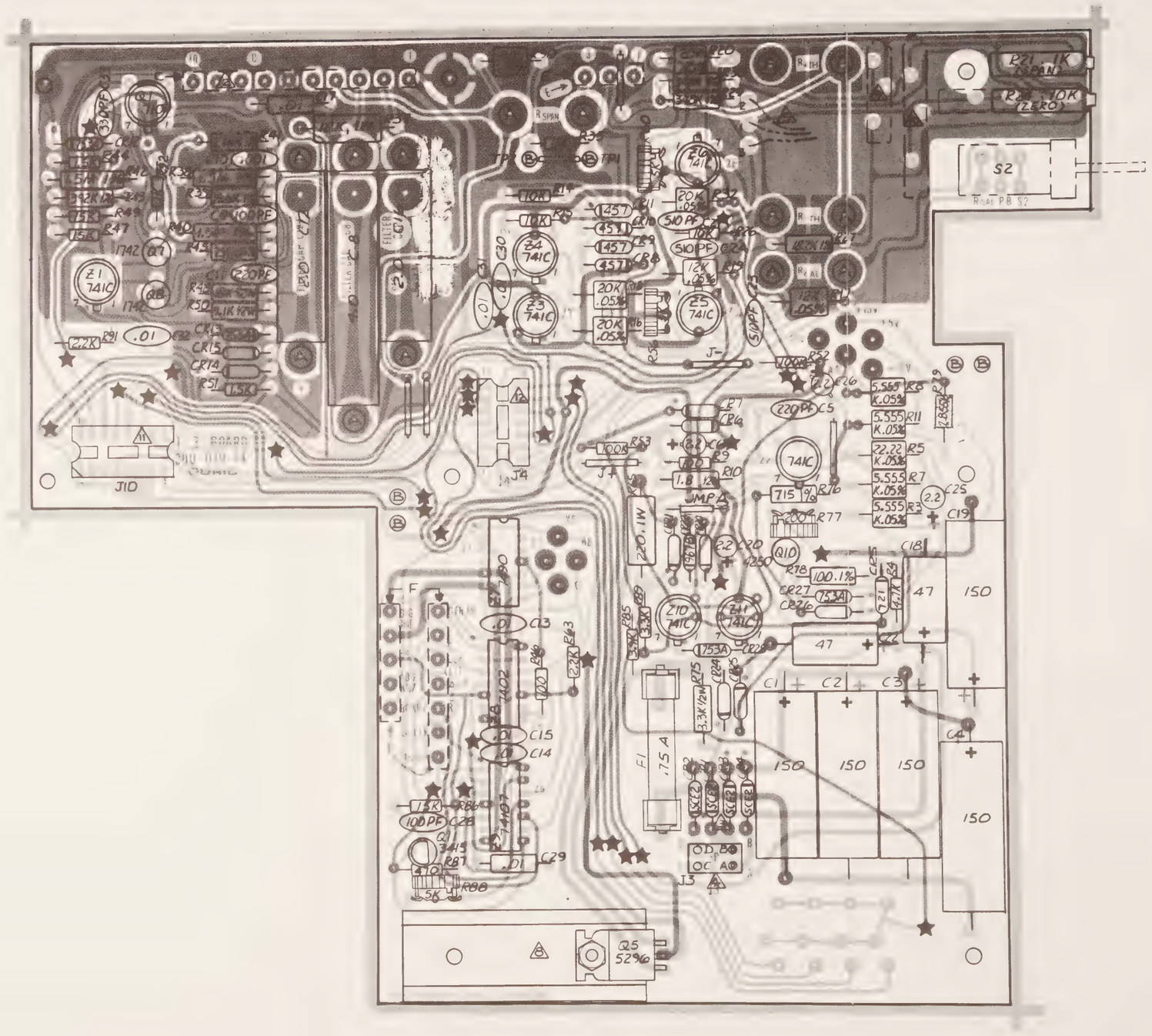
16. ALL 2-INPUT NOR GATES ARE SN74LS02 (PIN 7 GND/14 VCC).
15. ALL HEX INVERTERS ARE MC937 (PIN 7 GND/14 VCC)
14. ALL F/F ARE 74LS107 (PIN 7 GND/14 VCC).
13. ▬ INDICATES OPTION.
12. (A) = ANALOG GND. (D) = DIGITAL GND.
11. SELECTION OF HOLE "a" REQUIRES PLATING TO BE REMOVED FROM HOLE "b" AND PIN INSTALLED IN HOLE "a"
10. ⊖ INDICATES NON PLATED THRU SELECTION PAD.
9. ⊛ INDICATES PLATED THRU SELECTION PAD.
8. ⊛ INDICATES JUMPER NORMALLY INSTALLED.
7. ◎ INDICATES TEST POINT.
6. ▷ OR → INDICATES INTERNAL CONNECTION.
5. □ INDICATES J1 CONNECTOR PIN.
4. ELCO PINS INDICATED BY ◯ ← A ("A" = ROW)
   B = IO BOARD
   C, D, E, F } T2 BOARD
3. CAPACITOR VALUES ARE µf.
2. RESISTORS ARE 1/4W, 5%, IN OHMS.
1. ALL DIODES ARE IN914.

NOTES: UNLESS OTHERWISE SPECIFIED.

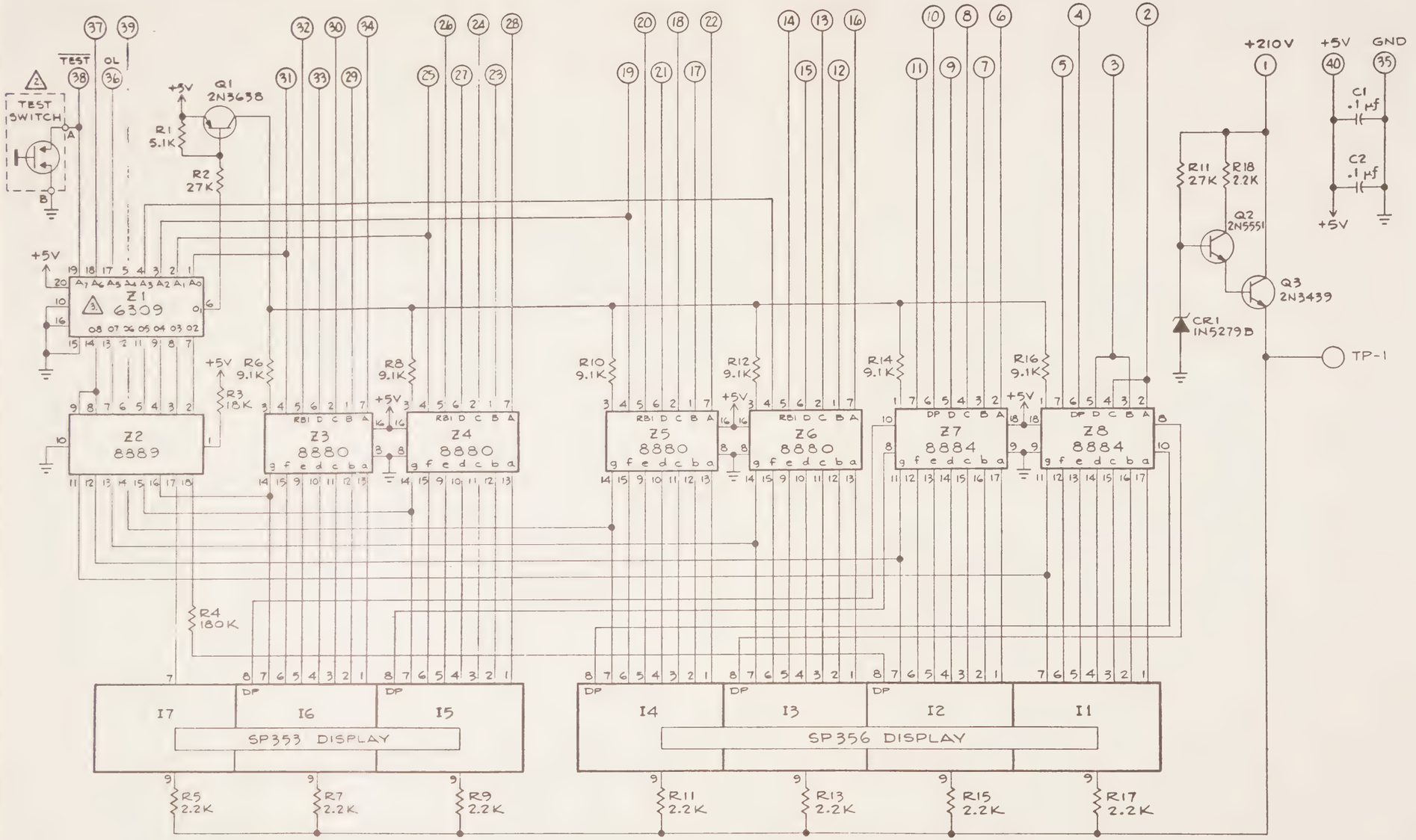
DS 300-T2A MOTHER BOARD, SCHEMATIC 300-6730-01


C41
8000
C40
100
R145
68,1/2W
Q28
7805
C86
470
C85
.33
C58
.0047
R159
47
R147
470
.02
C68
Q32
4D347
Q33
4D404
C42
270
C43
270
C46
.002
CR21
CR23
CR22
CR24
CR20
CR26
R152
150K
15.3K
1.78K
CR25
CR27
4002
R164 5K
Z38
741C
Z39
741C
.002
C62
.002
C63
2202
Q2
Q3
2202
R8
R10
39K
47K
C45
.002
R140
R146
R163
R115
R155
R150
R153
R154
R162
76.8K
5.11K
2.21K
470
680
39.2K
9.66K
11K
100K
47
R179
R12
R13
R14
1K
1K
10K
10K
5K
R11
R142
82.5K
R141
220K
R17
105K
R18
105K
R19
2.49K
R143
2.49K
C54
470 pF
R144
5.11K
R21
100K
R20
100K
R26
16.2K
C9
R39
R36
R40
R35
100K
C10
.1
R24
9.31K
R27
22
R30
680K
R31
220K
R32
1M
C13
BA25
22
Q12
Q14
Q15
R42
1K
R41
1M
R45
18.2K
R135 1K
C12
100pF
Q11
2202
R33
R34
680K
220K
R52
R36
150K
150K
R34
150K
C53
100 pF
C11
.01
C60
100pF
R48
1K
C7
.0068
R23
1K
R25
1.5K
R29
1K
R28
6.28K
Q4
1648
Q5
TP71D
Q7
Q8
4250
4250
C89
4.3
R47
R37
3393
3877
3393
3877
3877
Q16
Q15
Q19
Q18
Q17
C70
220pF
C69
.01
R46
R54
R53
R50
R51
22K
22K
22K
22K
R55
15K
Z9
837
Z10
837
Z7
837
Z8
837
CABLE ASSEMBLY
300-5108-XX
J8
J6
Z14
74LS02
Z19
74LS02
Z29
74LS02
Z37
74LS107
Z15
74LS02
Z20
74LS02
Z24
935
Z30
74LS107
Z31
74LS107
Z41
R172
F
F
Z1
74LS390
Z25
Z3
74LS390
Z5
74LS175
Z4
74LS175
Z2
74LS175
Z27
74LS74
Z32
74LS74
Z34
74LS123
C83
.005
C81
C82
C49
C48
C79
C80
C51
C50
C47
C52
C67
C87
C73
R204
1.1K
R181
4.7K
.001
C75
R186
470K
CR41
1941
R199
470K
R205
470K
3415
3415
3415
MPSA13
CR44
914
C77A
.33
C77B
.22
GA2C
C72
.005
C78
.01
C84
10
R195
16.5K
1%
R201
22
R184
1M
R200
4.7K
R190
4.7K
R191
1M
R192
4.7K
R194
100
CABLE ASSEMBLY
300-5330-XX
Z16
1D6A224
S3
Z17
74C08
Z21
783-1-R 6.8K
Z18
74LS126
390
R203
1.5K
R202
MPSA13
R134
10K
R56
10K
R135
100
Q20
3415
390
R133
R71
4.7K
R70
4.7K
CR9
C69
.001
C70
.001
914
R24
2.21K
914
CR8
R171
390
R91
1.5K
R86
10K
C32
.001
C33
.01
B
C17
.001
CR10
914
R43
R75
1.5K
C34
.001
1.5K
C16
.01
R63
1K
R64
10K
.001
C18
.001
R65
1K
R66
24K
CR5
914
R67
4.7K
R68
4.7K
C21
22
R87
1K
C64
.01
C15
15pF
R118
4.7K
R117
4.7K
C39
.001
CR6
914
R40
390
Q21
Q23
Q22
3393
3393
4250
C88
.001
R140
100
C52
.001
R116
470
R180
4.7K
C76
.001
R202
1.5K
R201
22
R200
4.7K
C84
10
R195
16.5K
1%
R184
1M
C78
.01
C72
.005
R190
4.7K
R191
1M
R192
4.7K
R194
100
C77A
.33
C77B
.22
GA2C
R186
470K
CR41
R199
470K
R205
470K
3415
3415
3415
MPSA13
CR44
914
C83
.005
C81
C82
C49
C48
C79
C80
C51
C50
C47
C52
C67
C87
C73
R204
1.1K
R181
4.7K
.001
C75
R186
470K
CR41
1941


+15V PRECISION EXCITATION POWER SUPPLY
REMOTE TRANSDUCER
+EXC.
-SIG.
+SIG.
EARTH
-EXC.
+SENSE
R CAL
LO SENSE
-SENSE
SHIELD
CURRENT
CIRCUIT
HI
J2
J4
INPUT FILTER
R CAL. OPTION
S2
R12
SOT R CAL.
ANALOG OUTPUT
J4-9,15
COUNT BY 1,2 OR 5
400 KHz CLOCK
SN7490
MASTER CLK.
80 KHz CLK.
SN7402
DISPLAY COUNTER INPUT.
GATED CLK.
LO F/F CLK
RESET 2
LRR
ΔLR
74107
400KHz (Z7-14)
SIGNAL CONDITIONING CIRCUIT
+E REF
-E REF
SPAN POT
SUMMING JUNCTION
TP1
TP2
10. DIODES IN 914
9. ⬡ INDICATES ANALOG OUTPUT OPTION CONNECTOR J10
8. INDICATES STD. JUMPER
7. ● INDICATES COMP. LEAD SPRING SOCKET FOR A JUMPER;
COMP. LOCATED ON FRONT PANEL.
5. INTEGRATED CKTS. SN7402 & SN74107 PIN 7 = GND. PIN 14 = VCC.
4. ○ INDICATES ELCO PIN.
3. ◉ INDICATES THREADED TERM
2. RESISTORS ± 5%, 1/4-W, CARBON
1. ○—○ INDICATES JUMPER.
NOTES: (UNLESS OTHERWISE SPECIFIED.)



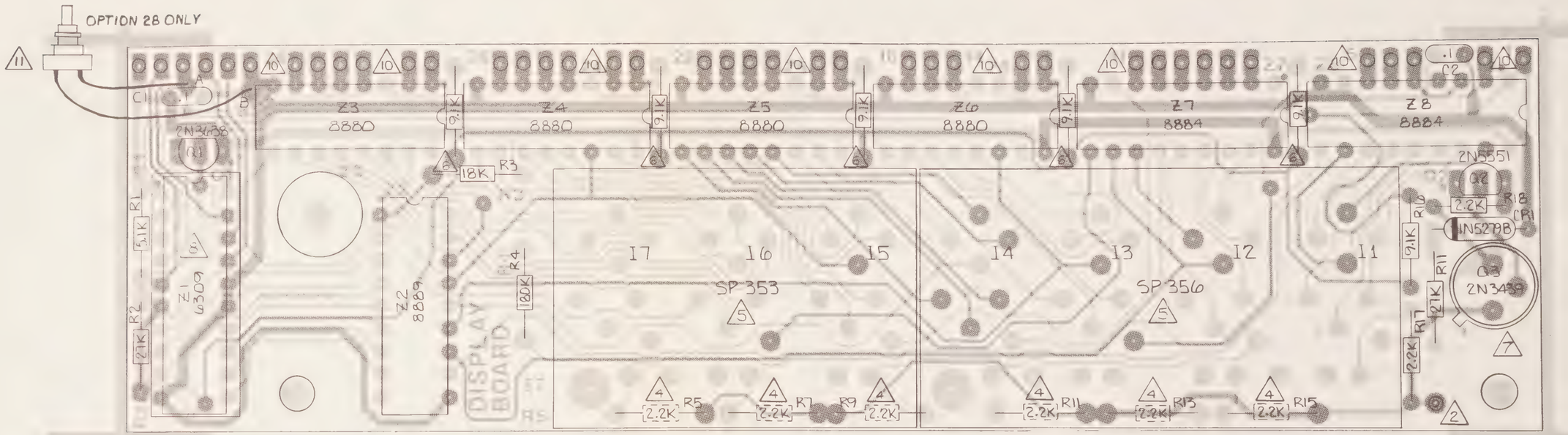
ASSEMBLY-
PLUG-ON BD.-T2
300-4390-14



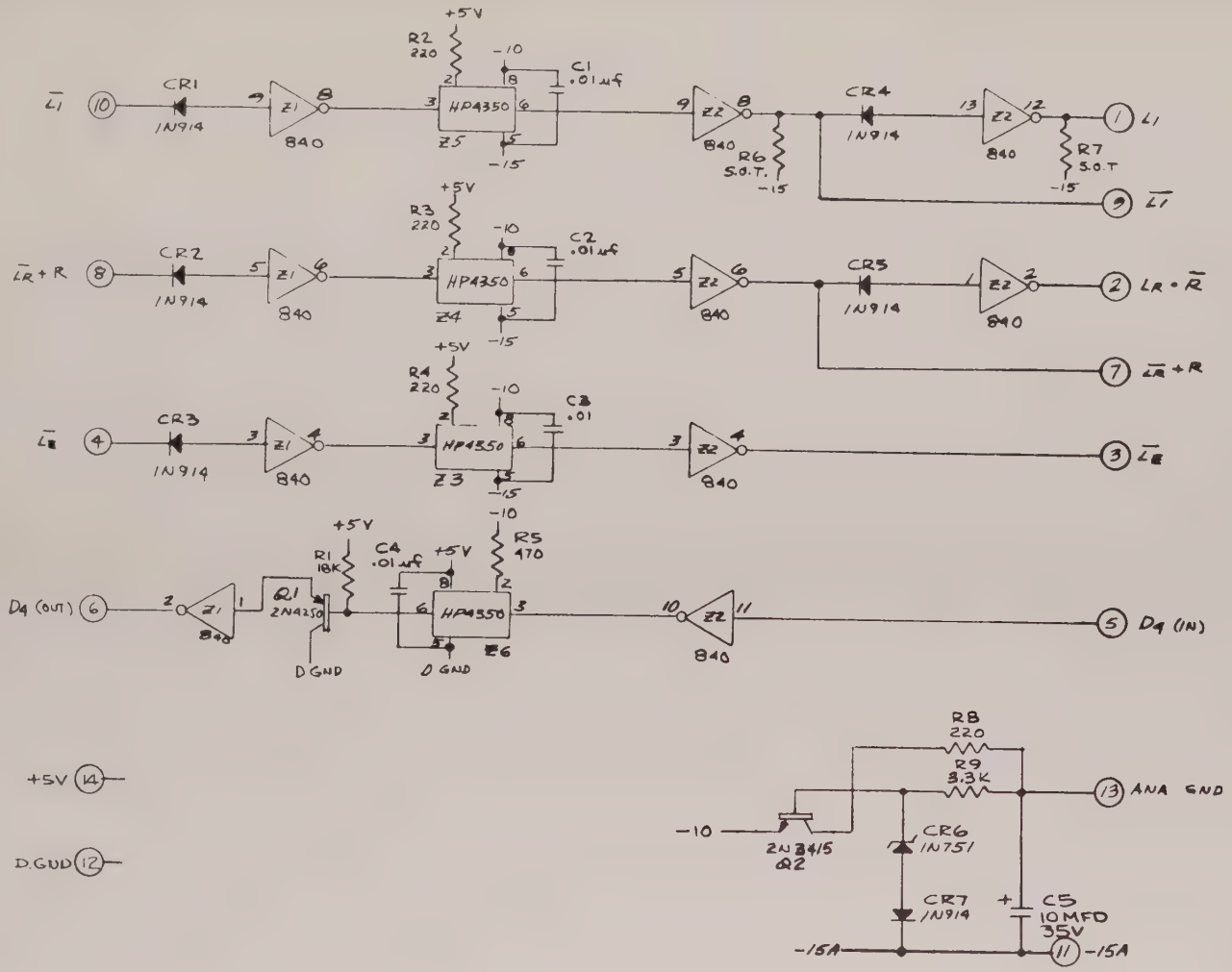
3. Z1 MAY BE 6309 OR 74S471.
2. TEST SWITCH INSTALLED ON FRONT PANEL. (OPTIONAL)
1. ALL RESISTORS ARE 1/8 W CARBON, IN OHMS.

NOTES: UNLESS OTHERWISE SPECIFIED.

DISPLAY BOARD,
SCHEMATIC 300-6740-01



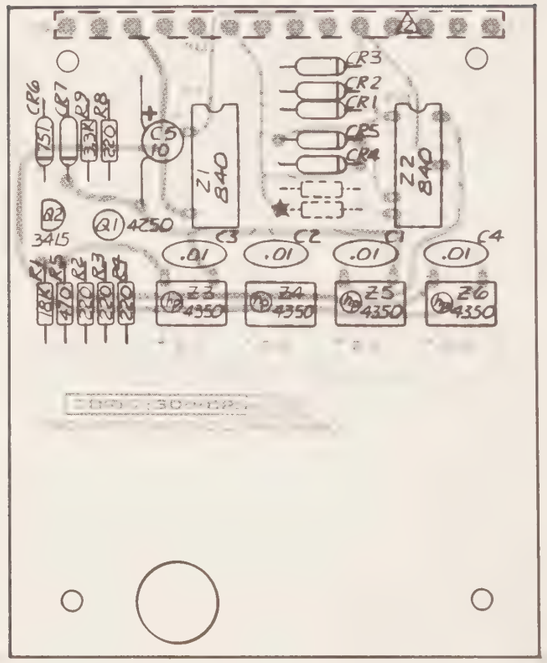
DISPLAY BOARD,
ASSEMBLY 300-4740-02



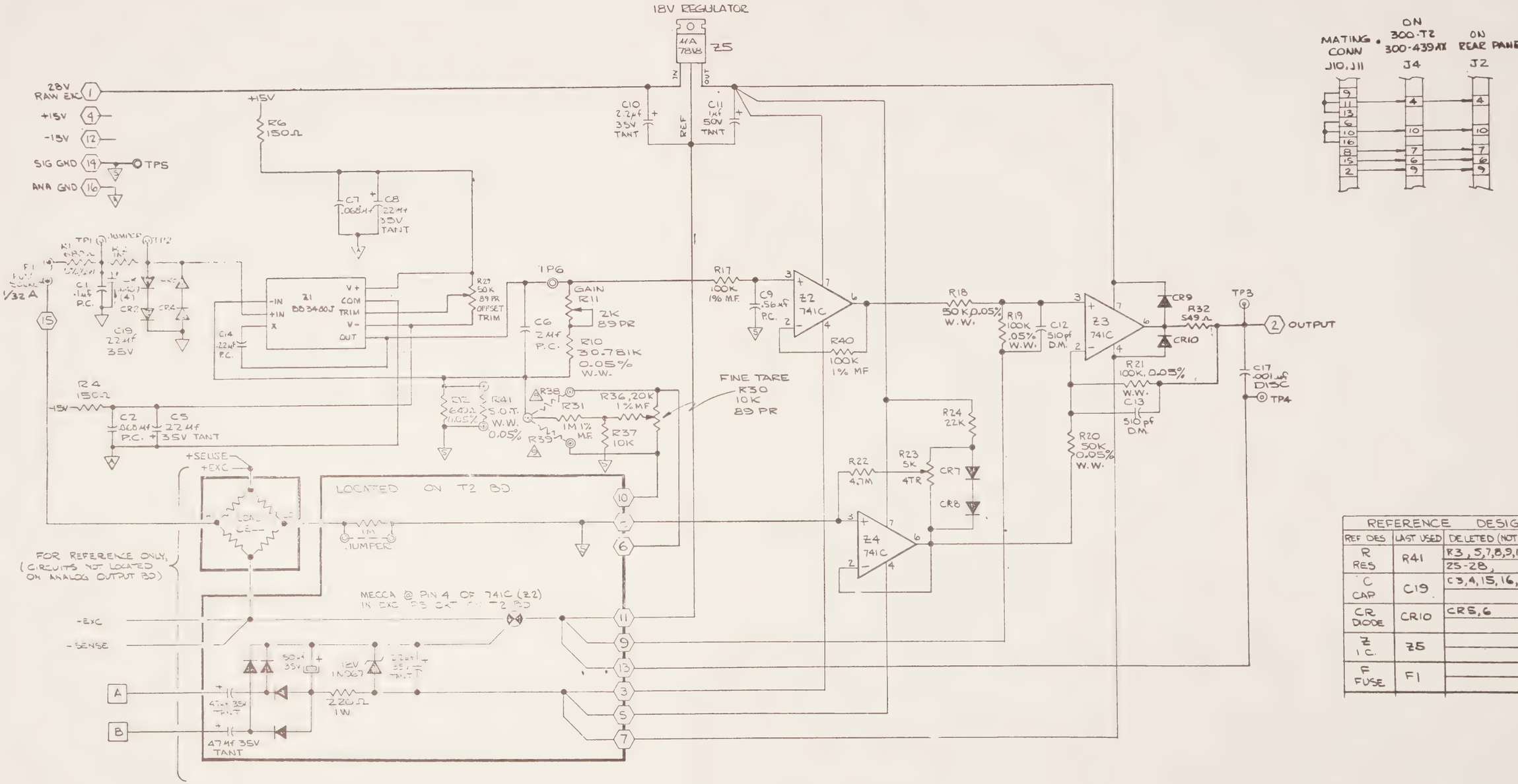
2. Z2 PIN 7 -15V. PIN 14 -10V
1. Z1, PIN 7 D GND. PIN 14 +5V

NOTES:

SCHEMATIC - OPTION S6P
ISOLATED BCD OUTPUTS



ASSEMBLY- OPTION S6P
ISOLATED BCD OUTPUT
300-425-10



REFERENCE DESIGNATORS		
REF DES	LAST USED	DELETED (NOT TO BE RE-USED)
R RES	R41	R3, 5, 7, 8, 9, 13, 14, 15, 16, 25-28, 33, 34, 35
C CAP	C19	C3, 4, 15, 16, 18
CR DIODE	CR10	CR5, 6
Z I.C.	Z5	
F FUSE	F1	

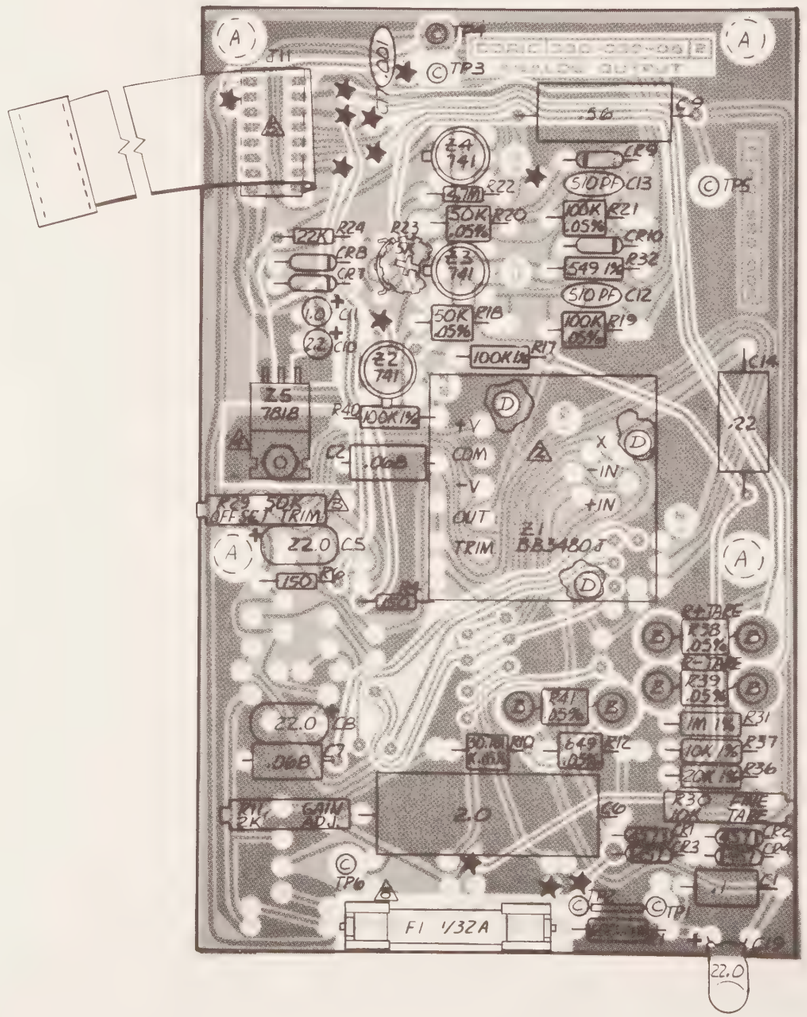
△ R39 COARSE(-) TARE
△ R38 COARSE (+) TARE

7 ▽ SIGNAL GND
6 ▽ ANALOG GND
5. ⬡ ANALOG OUTPUT OPTION CONNECTOR. J11 (3M-16Pin.)
4. ◎ INDICATES TURRET TERMINAL
3. ALL 1% RESISTORS ARE M.F., ±1%, RN60C
2. ALL RESISTORS ARE ¼W, 5%, CARBON
1. ALL DIODES ARE 1N914

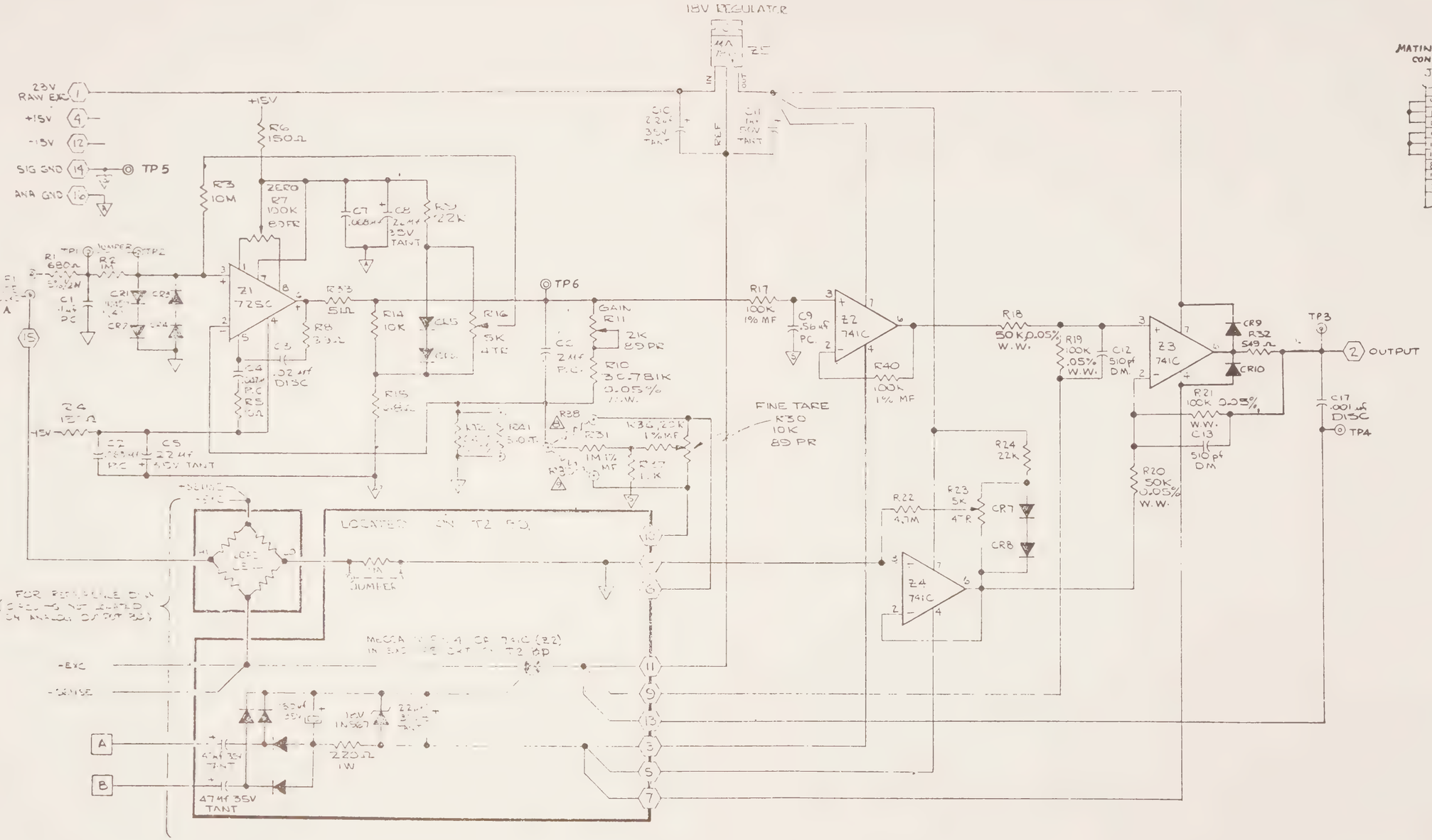
NOTES: UNLESS OTHERWISE SPECIFIED

ANALOG OUTPUT BOARD, OPTION 13-1

SCHEMATIC 300-6980-01



ASSEMBLY- ANALOG OUTPUT
OPTION 13-1 (CHOPPER AMPLIFIER)
300-4980-03



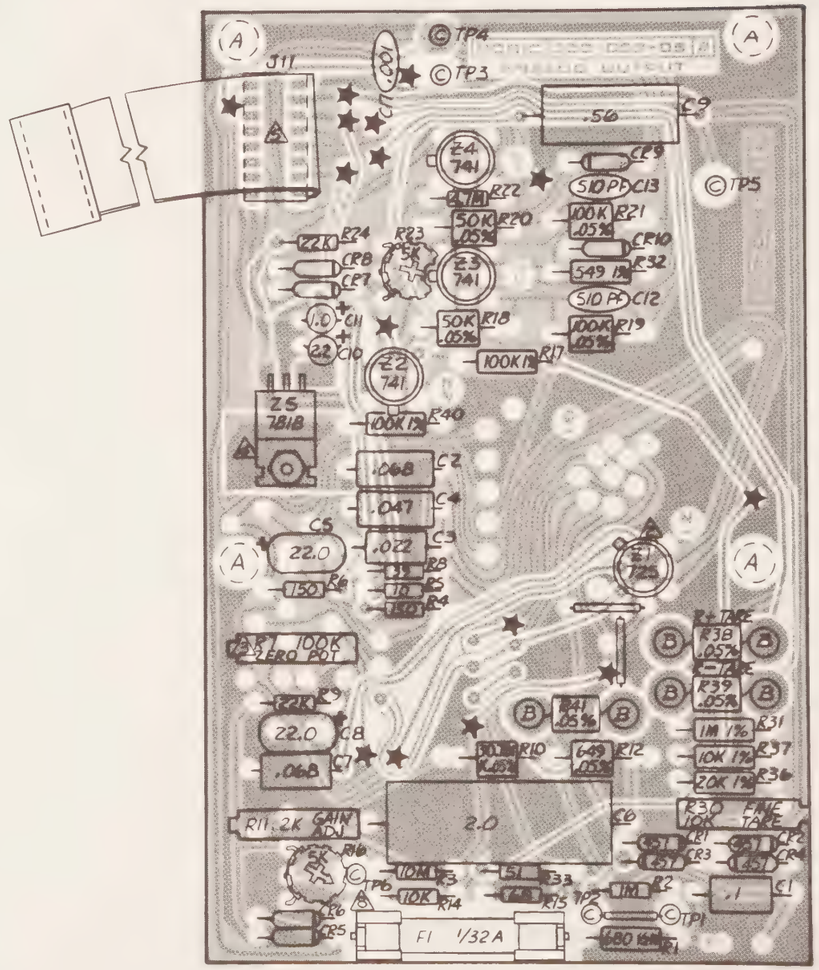
⚠ R30 COARSE(-) TARE
⚠ R38 COARSE (+) TARE

7 ▽ SIGNAL GND
5 ▽ ANALOG GND
5 ⬡ ANALOG OUTPUT OPTION CONNECTOR J11 (3M 16 PIN)
4 ⓒ INDICATOR TURRET TERMINAL
3 ALL 1% RESISTORS ARE MF, ±1%, RN60C
2 ALL RESISTORS ARE: ¼W, 5%, CARBON
1 ALL DIODES ARE 1N914

NOTES: UNLESS OTHERWISE SPECIFIED

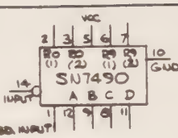
ANALOG OUTPUT BOARD, OPTION 13

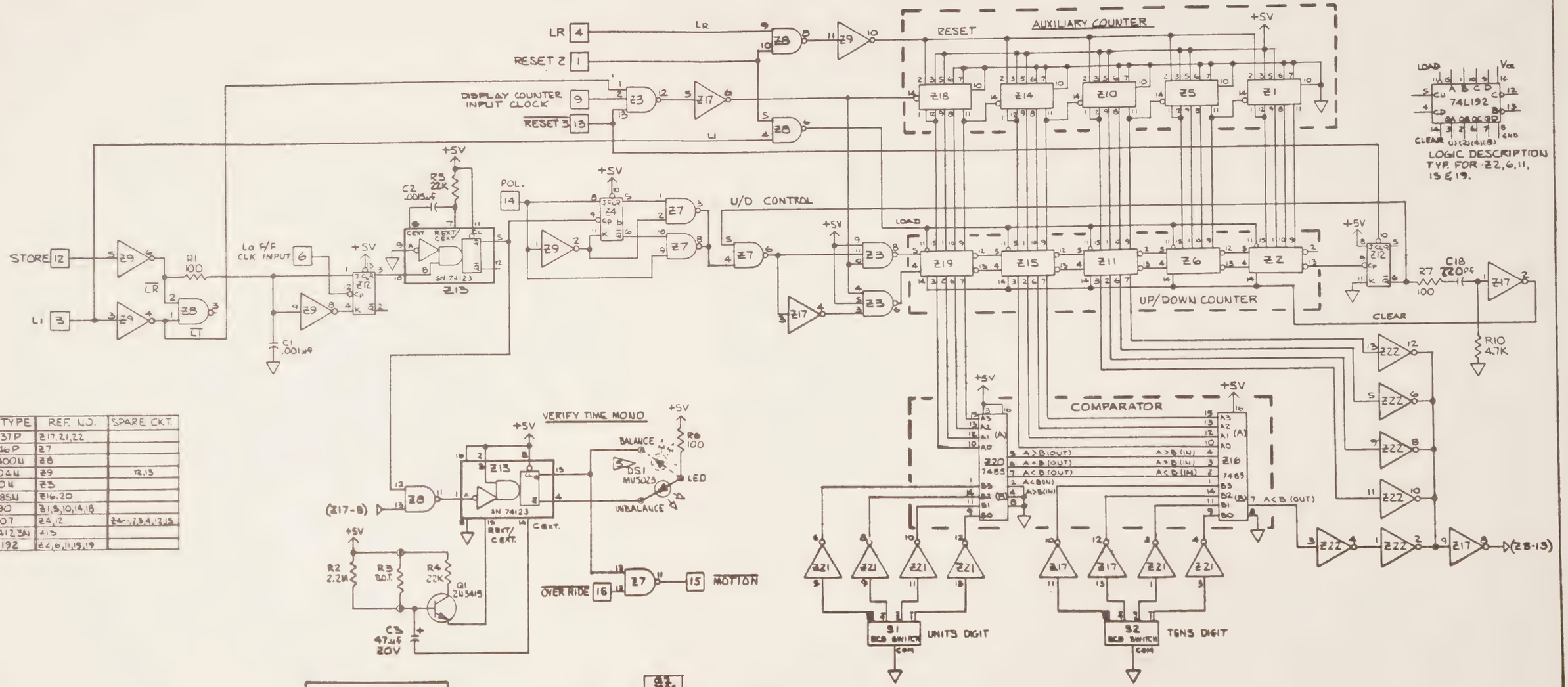
SCHEMATIC 300-6981-02



ASSEMBLY- ANALOG OUTPUT OPT.13
(BIPOLAR TRAN INPUT AMPLIFIER)
300-4981-02

LOGIC DESCRIPTION TYP. FOR Z1,5,10, 14 & 18.





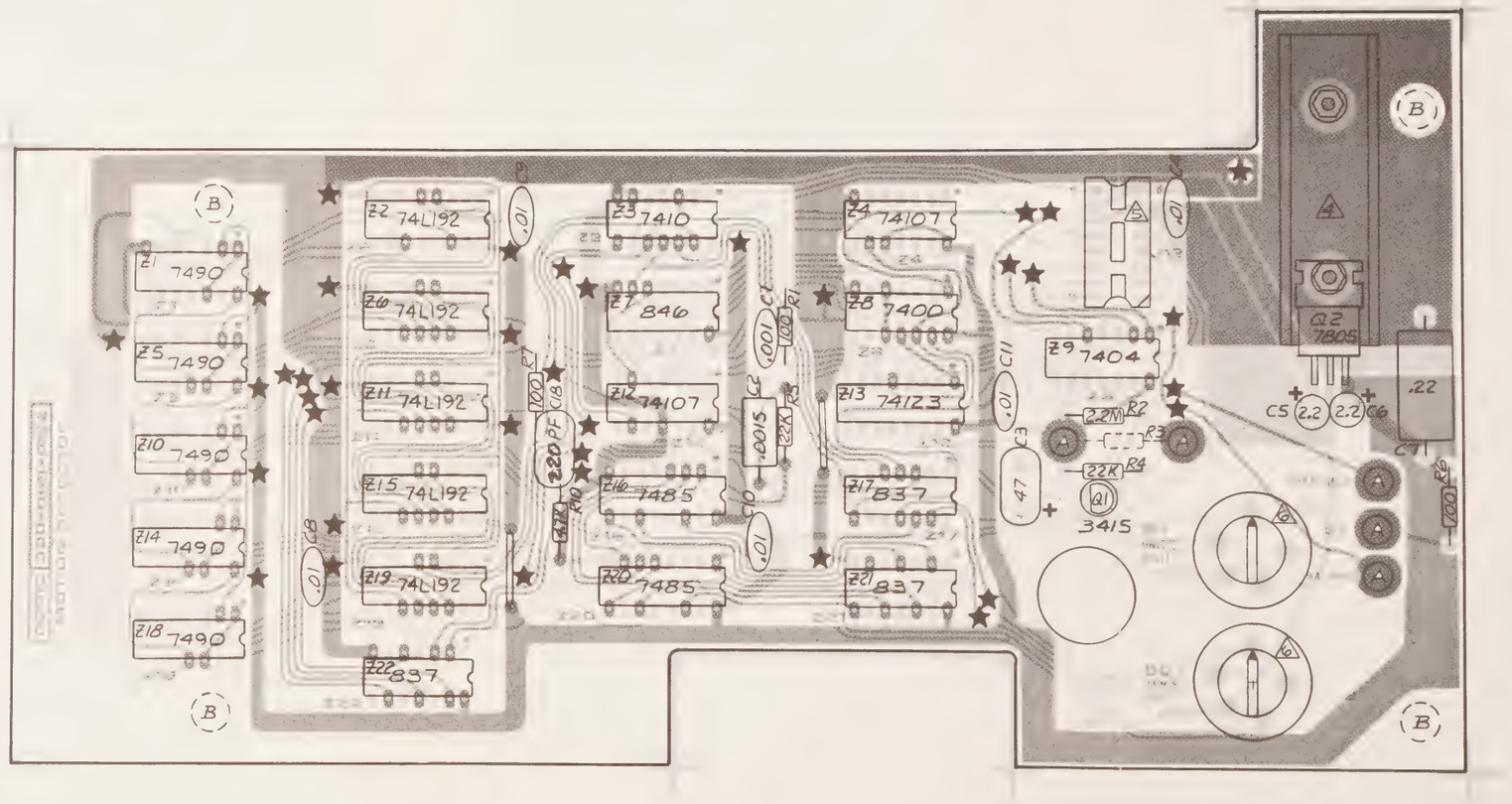
IC TYPE	REF. NO.	SPARE CKT.
MC837P	Z17,21,22	
MC846P	Z7	
SN7400N	Z8	
T7404N	Z9	12,13
T7410N	Z3	
SN7485N	Z16,20	
T7490	Z1,5,10,14,18	
T74107	Z4,12	Z4=1,2,3,4,12,13
SN74123N	Z13	
74L192	Z2,6,11,15,19	

TIMING CHART	
R5	TIME DELAY (T) APPROX. (±20%)
51K	0.6 SEC.
75K	1 SEC
150K	2 SEC.
220K	3 SEC.
300K	4 SEC.
390K	5 SEC

6. →0X← INDICATES INTERCONNECTIONS.
5. DS1 LOCATED ON FRONT PANEL OF DS-300-T2
4. ● INDICATES STANDOFF TERMINALS (S)
3. □ INDICATES J12 CONN, 10 PIN.
2. ⌐ INDICATES JUMPER
1. RESISTORS ±5% 1/4W, CARBON

NOTES: (UNLESS OTHERWISE SPECIFIED)

MOTION DETECTOR DS300-T2
Schematic 300-665-12



ASSEMBLY-
MOTION DETECTOR
300-465-09

SECTION 8

PARTS LIST

8.0 INTRODUCTION

Contained in this section is the complete parts list for the DS-300-T2A and its associated option boards.

Each list contains the reference designator, quantity used, Doric's part number, the manufacturer and their part number and Doric's recommended spares. Since certain parts appear more than once per list, the "quantity used" and the "recommended spares" will only appear once. The manufacturers part number has been deleted on those parts which are easily obtained by using only the description.

When ordering parts from Doric all correspondence should be made with reference to the Customer Service Department. A minimum order of $25.00 will only be accepted on all orders for parts.

FIGURE 8-1. T2A MOTHER BOARD, ASSEMBLY, 300-4730-02.

REF DES	DESCRIPTION	QTY	DORIC P/N	MFG and P/N		REC SPARES
C5	220 PF Duramica Cap	3	915-032-21	Sprague	DM15-221	
C7	.068 MFD 100V Polycarbonate	1	911-036-83	IMB	BA2B683	
C9	.01 MFD Disc Cap, 500V	6	900-021-04	Sprague		
C10	.1 MFD 100V Polystyrene	1	913-031-01	IMB	PA2B104	
C11	.01MFD Disc Cap, 500V		900-021-04	Sprague		
C12	100 PF Disc Cap, 1000V	3	901-011-01	Sprague		
C13	.22MFD 100V Polycarbonate	2	911-032-24	IMB	BA2B224	
C15	15 PF Duramica Cap	1	915-031-50	Sprague	DM15-150	
C16	.01 MFD Disc Cap, 500V		900-021-04	Sprague		
C17 thru C20	.002 Disc Cap, 1000V	14	900-081-03	Sprague	5GAD2	
C21	22 MFD 35V Tantalum	2	916-220-05	Sprague	196D226X0035	
C22	.001 Disc Cap, 1000V		900-081-03	Sprague	5GAD2	
C32 thru C34	.001 Disc Cap, 1000V		900-091-03	Sprague	5GAD2	
C39	.001 Disc Cap, 1000V		900-081-03	Sprague	5GAD2	
C40	100 MFD 250V, Electrolytic	1	910-061-07	Sprague	5GAD2	
C41	8000 MFD 15V, Electrolytic	1	910-801-16	Mallory		
C42,C43	270 MFD 40V, Electrolytic	2	910-270-40			
C45,C46	.002 MFD Disc Cap, 1000V	6	900-082-03	Sprague	5GAD2	
C47 thru C51	.1 MFD 50V	11	900-021-02			
C52	.001 Disc Cap, 1000V		900-081-03	Sprague	5GAD2	
C53	100 PF Disc Cap, 1000V		901-011-01	Sprague		
C54	470 PF Duramica Cap,	1	915-034-71	Sprague	DM15-471	
C55	.22 MFD 100V Polycarbonate		911-032-24	IMB	BA2B224	
C57	.002MFD Disc Cap, 1000V		900-082-03	Sprague	5GAD2	
C58	.0047 MFD 400V, Mylar	1	912-074-72	IMB	ZA2E472	
C59	4.7 MFD 35V, Tantalum	1	916-470-35	Sprague	196D475X0035	
C61	22 MFD 35V Tantalum		916-220-05	Sprague	196D226X0035	
C62,63	.002 MFD Disc Cap, 1000V		900-082-03	Sprague	5GAD2	
C64	.01 MFD Disc Cap, 500V		900-021-04	Sprague		
C66	100 PF Disc Cap, 1000V		901-011-01	Sprague		
C67	.01 MFD Disc Cap, 500V		900-021-04	Sprague		
C68	.02 MFD Disc Cap, 500V	1	900--082-02	Sprague		
C69	.002 MFD Disc Cap, 1000V		900-082-03	Sprague	5GAD2	
C70,C71	220 PF Duramica Cap		915-032-21	Sprague		
C72	.005 MFD Disc Cap, 1000V	1	900-085-03	Sprague		
C73 and C75	.001 Disc Cap, 1000V		900-081-03	Sprague		
C77a	.33 MFD 100V, Polycarbonate	2	911-033-34	IMB	BA2B334	
C77b	.22 MFD 200V, Polypropylene	1	917-022-20	IMB	GA2C224K	
C78	.01 MFD Disc Cap, 500V		900-021-04	Sprague		
C79 thru C83	.1MFD 50V		900-021-02			
C84	10 MFD 20V, Tantalum	1	916-010-20	Sprague	196D110X0035	
C85	.33 MFD 100V, Polycarbonate		911-033-34	IMB	BA2B334	
C86	470 MFD 10V, Electrolytic	1	910-470-16			
C87	.1 MFD 50V		900-021-02			
C88,C89	.001 Disc Cap, 1000V		900-081-03	Sprague		
CR2 thru CR5	1N914 Diode	12	961-091-40	Teledyne	1N914	3
CR8 thru CR10	1N914 Diode		961-091-40	Teledyne	1N914	
CR20	J-6 Rectifier 600V, 1A	1	966-002-04	Diodes Inc.	DS-6	1
CR21 thru CR25	1N4002 Rectifier 100V, 1A	6	966-002-00	Motorola	1N4002	4
C26	1N753A Diode	1	961-075-31	Teledyne	1N753A	1
CR27	1N4002 Rectifier 100V, 1A		966-002-00	Motorola	1N4002	
CR34	1N914 Diode		961-091-40	Teledyne	1N914	

FIGURE 8-1. T2A MOTHER BOARD, ASSEMBLY, 300-4730-02.(continued)

REF DES	DESCRIPTION	QTY	DORIC P/N	MFG and P/N		REC SPARES
CR41 thru CR44	1N914 Diode		961-091-40	Teledyne	1N914	
F2	.25 Amp Slo Blow Fuse	1	971-010-01	Littlefuse		
F2	.50 Amp Slo Blow Fuse		971-070-05	Littlefuse		
Q2,Q3	FET 2202, Low-Leak	4	100-722-02	Teledyne	1	
Q4	Dual FET FD-1648, Low Noise	1	100-725-01	Solitron	1	
Q5	Dual NPN -- KLG-710	1	100-733-00	LKG Tech	KLG710	1
Q7	2N4250 Transistor	5	962-425-00	Solitron	2N4250	2
Q11,Q12	FET 2202, Low-Leak		100-722-02	Teledyne		
Q13	FET U2061E	1	100-729-00	Teledyne		1
Q14	FET 1087E	1	100-730-00	Teledyne		1
Q15	2N3877A Transistor	3	962-387-71	National	2N3877A	1
Q16	2N3393 Transistor	4	962-339-30	National	2N3393	2
Q17,Q18	2N3877A Transistor		962-387-71	National	2N3877A	
Q19	2N3393 Transistor		962-339-30	National	2N3393	
Q20,Q38,Q39	2N3415 Transistor	3	962-341-50	GE	2N3415	1
Q21	2N3393 Transistor		962-339-30	National	2N3393	
Q22	2N4250 Transistor		962-425-00	Solitron	2N4250	
Q23	2N3393 Transistor		962-339-30	National	2N3393	
Q28	7805 Regulator 5V, 1A	1	965-551-00	Motorola	MC7805	1
Q32	40347 Power Transistor	1	064-040-00	RCA	40347	1
Q33	40406 Power Transistor	1	964-040-02	RCA	40406	1
Q36	MPSA13 Transistor	1	964-040-03	Motorola	MPSA13	1
R8	39K, .25W, 5%	1	942-203-93	Allen Bradley		
R10	47K, .24W, 5%	2	042-204-73	Allen Bradley		
R11	5K Pot Cermet (91Z)	2	960-015-02	Beckman	91Z5K	1
R12	1K, 1%, RN60D	1	920-310-01	Dale		
R13,R14	10K, 1%, RN60C	2	920-410-02	Dale		
R17,R18	165K, 1%, RN60C	3	920-416-54	Dale		
R19	249K, 1%, RN60C	1	920-424-93	Dale		
R20,R21	100K, 1%, RN60C	3	920-310-03	Dale		
R23	1K, .25W, 5%	7	942-201-02	Allen Bradley		
R24	4.7K, .25W, 5%	11	942-204-72	Allen Bradley		
R25,R55	15K, .25W, 5%	2	942-201-53	Allen Bradley		
R26	16.2K, 1%, RN60C	1	920-416-22	Dale		
R27	22 OHM, .25W, 5%	2	942-202-20	Allen Bradley		
R28	6.2K, .25W, 5%	1	942-206-22	Allen Bradley		
R29	1K, .25W, 5%		942-201-51	Allen Bradley		
R30	68K, .25W, 5%	1	942-206-83	Allen Bradley		
R31	220K, .25W, 5%	3	942-202-24	Allen Bradley		
R32	1 Meg, .25W, 5%	4	942-201-05	Allen Bradley		
R33	680K, .25W, 5%	1	942-206-84	Allen Bradley		
R34	220K, .25W, 5%		942-202-24	Allen Bradley		
R35	100K, .25W, 5%		942-201-04	Allen Bradley		
R36	10 Meg., .25W, 5%	1	042-201-06	Allen Bradley		
R39,R40	161.775K, .05%, WW	2	934-211-44	Jordan Electric	J115	
R41,R42	1 Meg, .25W, 5%		942-201-05	Allen Bradley		
R45	18.2K, 1%, RN60C	1	920-418-22	Dale		
R46,R47	22K, .25W, 5%	7	942-202-23	Allen Bradley		
R48	150K, .25W, 5%	3	942-201-54	Allen Bradley		
R50,R51	22K, .25W, 5%		942-202-23	Allen Bradley		
R52	150K, .25W, 5%		942-201-54	Allen Bradley		
R53,R54	22K, .25W, 5%		942-202-23	Allen Bradley		

FIGURE 8-1. T2A MOTHER BOARD, ASSEMBLY, 300-4730-02. (continued)

REF DES	DESCRIPTION	QTY	DORIC P/N	MFG and P/N		REC SPARES
R58	10K, .25W, 5%	4	942-201-03	Allen Bradley		
R60	390 OHM, .25W, 5%	4	942-203-91	Allen Bradley		
R61,R62	4.7K, .25W, 5%		942-204-72	Allen Bradley		
R63	1K, .25W, 5%		942-201-02	Allen Bradley		
R64	10K, .25W, 5%		942-201-03	Allen Bradley		
R65	1K, .25W, 5%		942-201-02	Allen Bradley		
R66	24K, .25W, 5%	1	942-202-43	Allen Bradley		
R67	1K, .25W, 5%		942-201-02	Allen Bradley		
R70,R71	4.7K, .25W, 5%		942-204-72	Allen Bradley		
R72	22K, .25W, 5%		942-202-23	Allen Bradley		
R74	2.2K, .25W, 5%	1	942-202-22	Allen Bradley		
R75	1.5K, .25W, 5%	4	942-201-52	Allen Bradley		
R86,R87,R89	1.5K, .25W, 5%		942-201-52	Allen Bradley		
R117,R118	4.7K, .25W, 5%		942-204-72	Allen Bradley		
R120	150K, .50W, 5%	1	942-301-54	Allen Bradley		
R134	10K, .25W, 5%		942-201-03	Allen Bradley		
R135	1K, POT, CERMET	1	960-011-02	Beckman	89PR1K	
R137	10K, .25W, 5%		942-201-03	Allen Bradley		
R140	100 OHM, .25W, 5%	3	942-201-01	Allen Bradley		
R141	20K, 1%, RN60C	1	920-420-02	Dale		
R144	5.11K, 1%, RN60D	2	920-351-11	Dale		
R145	68 OHM, .50W, 5%	1	942-306-80	Allen Bradley		
R146	150K, .25W, 5%		942-201-54	Allen Bradley		
R147	390 OHM, .25W, 5%		942-203-91	Allen Bradley		
R148	1K, .25W, 5%		942-201-02	Allen Bradley		
R150	19.6K, 1%, RN60D	1	920-319-62	Dale		
R151	39.2K, 1%, RN60D	1	920-339-22	Dale		
R152	1.78K, 1%, RN60C	1	920-417-81	Dale		
R153	11K, 1%, RN60C	1	920-411-02	Dale		
R154	100K, 1%, RN60C		920-310-03	Dale		
R155	680 OHM, .25W, 5%	1	942-206-81	Allen Bradley		
R159	47 OHM, .25W, 5%	2	942-204-70	Allen Bradley		
R160	7.5K, 1%, RN60C	1	920-475-01	Dale		
R161	5.11K, 1%, RN60D		920-351-11	Dale		
R162	47 OHM, .25W, 5%		942-204-70	Allen Bradley		
R163	1.21K, 1%, RN60C	1	920-412-11	Dale		
R164	5K Pot Cermet (91Z)		960-015-02	Beckman	91Z5K	
R165	100 OHM, .25W, 5%		942-201-01	Allen Bradley		
R166	4.7K, .25W, 5%		942-204-72	Allen Bradley		
R171	390 OHM, .25W, 5%		942-203-91	Allen Bradley		
R174,R175,R176	470 OHM, .25W, 5%	3	942-204-71	Allen Bradley		
R179	1K, .25W, 5%		942-201-02	Allen Bradley		
R180	47K, .25W, 5%		942-204-73	Allen Bradley		
R181	4.7K, .25W, 5%		942-204-72	Allen Bradley		
R184	1MEG, POT, CERMET	1	960-011-13	Beckman	89PR1M	
R186,R188,R199	470K, .25W, 5%	3	942-204-74	Allen Bradley		
R190	4.7K, .25W, 5%		942-204-72	Allen Bradley		
R191	1 Meg, .25W, 5%		942-201-05	Allen Bradley		
R192	4.7K, .25W, 5%		942-204-72	Allen Bradley		
R194	100 OHM, .25W, 5%		942-201-01	Allen Bradley		
R195	165K, 1%, RN60C		920-416-53	Dale		
R201	220HM, .25W, 5%		942-202-20	Allen Bradley		

FIGURE 8-1. T2A MOTHER BOARD, ASSEMBLY, 300-4730-02. (continued)

REF DES	DESCRIPTION	QTY	DORIC P/N	MFG and P/N		REC SPARES
R201	22 OHM, .25W, 5%		942-202-20	Allen Bradley		
R204	1K, .25W, 5%		942-201-02	Allen Bradley		
R203	390 OHM, .25W, 5%		942-203-91	Allen Bradley		
R205	220K, .25W, 5%		942-202-24	Allen Bradley		
T1	Variable Transformer B6385	1	100-703-02			
Z1,Z3,Z11	74LS390 Dual Decade Ctr.	3	965-635-47	Texas Instruments	SN74LS390	1
Z2,Z4,Z5	74LS175 Quad D F/F	5	965-635-46	Texas Instrument	SN74LS175	2
Z7 thru Z10	MC 837P Hex Inverter	4	965-524-00	Motorola	MC837P	2
Z14,Z15	74LS02 Quad 2-In Nor	5	965-635-17	Texas Instruments	SN74LS02	2
Z16	Resistor NWK, 5-220K	1	950-022-03	Allen Bradley	106A224-220K	
Z17	74C08 Quad 2-In Nor	1	965-565-01	Motorola	74C08	1
Z18	74LS126 Quad Buffer	1	965-635-45	Texas Instruments	SN74LS126	1
Z19,Z20	74LS02 Quad 2-In Nor		965-635-17	Texas Instruments	SN74LS02	
Z21	Resistor NWK, 5-6.8K	1	950-068-03	Beckman	783-1-6.8K	
Z24	MC 840P Hex Inverter	1	965-522-00	Motorola	MC840P	
Z27,Z32	74LS74 Dual D F/F	2	965-635-19	Texas Instruments	SN74LS74	1
Z29	74LS02 Quad 2-In Nor		965-635-17	Texas Instruments	SN74LS02	
Z30 and Z31	74LS107 Dual JK F/F	3	965-635-24	Texas Instruments	SN74LS107	1
Z34	74LS123 Dual Mono F/F	1	965-635-27	Texas Instruments	SN74LS123	1
Z37	74LS107 Dual JK F/F		965-635-24	Texas Instruments	SN74LS107	
Z38 thru Z40	741C OP AMP	3	965-506-00	Fairchild	741C	1
	Cable Assy., I/O	1	300-5180-00			*
	Cable Assy., Flex Print	1	300-5330-00			*
	PCB, 300T2A Digital Board	1	300-2730-01			*
	Heatsink, U Shape Print	1	500-221-00			*
	Elco Pin (02-060-114-6200)	40	973-080-01			*
	Conn, PC 7(M) (Molex)-6200)	1	973-095-02			*
	Conn, PNL MT(F)	1	973-150-02			*
	SCREW 4-40X¼ NYL	3	982-440-025			*
	HEATSINK, TO5 NYL	2	991-001-01			*
	Stdf, 7/16X440A3L	12	991-020-01			*
	Turret Terminal (L3645-3S)	4	991-020-65			*
	Bracket Rt. Angle	2	992-040-57			*
	Rivet, 1/8DX5/32L	2	991-040-58			*
	Xstr Clip, (Wklfd 259-18-25)	1	992-010-01			*
	IC Socket, 14DIP	4	992-010-07			*
	Bussbar, 7 Pin (900433)	7	922-010-61			*

*Component without reference designator, order from DORIC if required.

FIGURE 8-2. T2A PLUG-ON BOARD, ASSEMBLY, 300-4390-14.

REF DES	DESCRIPTION	QTY	DORIC P/N	MFG and P/N		REC SPARES
C1 thru C4	150 Mfd 35V Electrolytic	5	910-150-35	Mallory	MTA 150F35	
C5	.068 Mfd 100V Polycarbonate	1	911-036-83	IMB	BA2B683	
C6	2.2 Mfd 35V Tantalum	4	916-220-02	Sprague	196D226X0035	
C8	4.0 Mfd 100V Polycarbonate	1	911-034-05	IMB	BA2B405	
C9	100PF Disc Cap, 1000V	2	901-011-01	Sprague		
C10	.001 Mfd Disc Cap, 1000V	1	900-081-03	Sprague		
C11	220PF Disc Cap, 1000V	1	901-012-21	Sprague		
C12	2.0 Mfd 100V Polycarbonate	2	911-032-05	IMB	BA2B205	
C13 thru C15	.01 Mfd Disc Cap, 500V	5	900-012-04	Sprague		
C16	2.0 Mfd 100V Polycarbonate		911-032-05	IMB	BA2B205	
C17	.01 Mfd 100V Polycarbonate	2	911-031-04	IMB	BA2B104	
C18	47 Mfd 35V Electrolytic	2	910-470-35	Sprague		
C19	150 Mfd 35V Electrolytic		910-150-35	Mallory	MTA 150F35	
C20	2.2 Mfd 35V Tantalum		916-220-04	Sprague	196D226X0035	
C22	47 Mfd 35V Electrolyte		910-470-35	Sprague		
C23,C24	510 Duramica Cap.	3	915-035-11	Sprague	DM 15-551	
C25, C26	2.2Mfd 35V Tantalum		916-220-04	Sprague	196D226X0035	
C27	510PF Duramica Cap.		915-035-11	Sprague	DM 15-551	
C28	100PF Disc Cap, 1000V		901-011-01	Sprague		
C29	.01 Mfd 100V Polycarbonate		911-031-04	IMB	BA2B104	
C3,C31,C32	.01 Mfd Disc Cap, 500V		900-021-04	Sprague		
CR1 thru CR4	SD-2 200V Rectifier	4	966-002-00	Diodes, Inc.		2
CR6,CR7	1N914 Diode	9	961-091-40	Teledyne		3
CR8 thru CR11	1N457A Diode	8	961-045-70	Teledyne		3
CR12, CR13	1N753A Diode	4	961-075-31	Teledyne	SD-2	2
CR14, CR15	1N914 Diode		961-091-40	Teledyne		
CR16 thru CR19	1N924 Diode		961-045-70	Teledyne		
CR20,CR21	1N914 Diode		961-091-40	Teledyne		
CR22	1N967B Diode	1	961-096-72	Teledyne		1
CR24 thru CR26	1N914 Diode		961-091-40	Teledyne		
CR27,CR28	1N753A Diode	4	961-075-31	Teledyne	SD-2	
F1	¾ Amp Slow Blow 3AG Fuse	1	971-070-11	Littlefuse		1
Q1	Dual NPN-KLG-710	1	100-733-00	KLG Tech	KLG 710	1
Q5	2N5296 Power Transistor	1	964-529-60	RCA		1
Q7,Q8	FET U1742C Low Leak	2	100-722-02	Teledyne	U1742C	1
Q10	2N4250 Transistor	1	962-425-00	Solitron		1
Q11	2N3415 Transistor	1	962-341-50	GE	2N3415	1
R3	5.555K .05% WW	5	934-215-52	Jordan Elec.	J-115	
R4	4.7K ¼W 5%	1	942-204-72	Allen Bradley		
R5	22.22K .05% WW	1	934-211-95	Jordan Elec.	J-115	
R6	100 ohm ¼W 5%	3	942-201-01	Allen Bradley		
R7,R8	5.555K .05% WW		934-215-52	Jordan Elec.	J-115	
R9	100 ohm ¼W 5%		942-201-01	Allen Bradley		
R10	1.8 OHM ½W 5%	1	942-301-89	Allen Bradley		
R11	5.555K .05% WW		934-215-52	Jordan Elec.	J-115	
R14,R15	10K ¼W 5%	4	942-201-03	Allen Bradley		
R16	20K .05% WW	4	934-212-03	Jordan Elec.	J-115	
R17	12K .05% WW	2	934-211-43	Jordan Elec.	J-115	
R18	20K .05% WW		934-212-03	Jordan Elec.	J-115	
R19	12K .05% WW		934-211-43	Jordan Elec.	J-115	
R20	20K 1% RN60C	2	920-420-02	Dale		
R21	1K Pot, Cermet	1	960-011-02	Beckman		1
R23	100K, ¼W, 5%		942-201-04	Allen Bradley		
R26	10K ¼W 5%		942-201-03	Allen Bradley		
R27	16.2K 1% RN60C	1	920-416-22	Dale		
R29,R30	1Meg 1% RN60C	2	920-410-04	Dale		

FIGURE 8-2. T2A PLUG-ON BOARD, ASSEMBLY, 300-4390-14. (continued)

REF DES	DESCRIPTION	QTY	DORIC P/N	MFG and P/N		REC SPARES
R32	20K .05% WW		934-212-03	Jordan Elec.	J-115	
R35	1Meg ¼W 5%	1	942-201-05	Allen Bradley		
R37	18K 1W 5%	1	942-401-83	Allen Bradley		
R38	1.5Meg 1% RN65D	3	920-315-04	Dale		
R39	19.6K 1% RN60D	1	920-319-62	Dale		
R40	1.5 Meg 1% RN65D		920-315-04	Dale		
R41	274K 1% RN60D	1	920-327-43	Dale		
R42	1.5 Meg 1% RN65D		920-315-04	Dale		
R43	392K 1% RN60D	1	920-339-23	Dale		
R44	1.5K ¼W 5%	2	942-201-52	Allen Bradley		
R45	750K 1% RN60D	1	920-375-02	Dale		
R46	100 ohm ¼W 5%		942-201-01	Dale		
R47	15K ¼W 5%	3	942-201-53	Allen Bradley		
R48	18K ½W 5%	1	942-301-83	Allen Bradley		
R49	15K ¼W 5%		942-201-53	Allen Bradley		
R50	9.1K ½W 5%	1	942-309-12	Allen Bradley		
R51	1.5K ¼W 5%		942-201-52	Allen Bradley		
R52,R53	100K ¼W 5%	2	942-201-04	Allen Bradley		
R56	5K Pot Beckman, 91Z	2	960-015-01	Beckman		1
R58	1.21K 1% RN60C	1	920-412-11	Dale		
R60	5K Pot Beckman, 91Z		960-015-01	Beckman		
R63	2.2K ¼W 5%	1	942-202-22	Allen Bradley		
R63	220 ohm 1W 5%	1	942-402-21	Allen Bradley		
R75	3½3K ½W 5%	1	942-303-32	Allen Bradley		
R76	715 ohm 1% RN60C	1	920-471-50	Dale		
R77	200 ohm Pot Beckmen 91Z	1	960-015-02	Beckman		1
R78	1000 ohm 1% RN60D	1	920-310-00	Dale		
R79	5.555K .05% WW		934-215-52	Jordan Elec.	J-115	
R85	3.9K ¼W 5%	1	942-203-92	Allen Bradley		
R86	15K ¼W 5%		942-201-53	Allen Bradley		
R87	10K ¼W 5%		942-201-03	Allen Bradley		
R89	3.3K ¼½w 5%	1	942-203-32	Allen Bradley		
R90	20 ohm .05% WW	1	937-201-07	Jordan Elec.		
R91	2.2K ¼W 5%	1	942-202-22	Allen Bradley		
Z1 thru Z6	741C OP Amp	8	965-506-00	Fairchild		3
Z7	T 7490 Counter	1	965-518-00	Texas Inst.		1
Z8	T 7402 Gate	1	965-516-00	Texas Inst.		1
Z9	T 74107 JK Flip Flop	1	965-520-00	Texas Inst.		1
Z10,Z11	741C OP Amp		965-506-00	Fairchild		

FIGURE 8-3. ISOLATED BCD OUTPUT BOARD (OPTION S6P), ASSEMBLY 300-425-10

REF DES	DESCRIPTION	QTY	DORIC P/N	MFG and P/N		REC SPARES
C1 thru C4	.01 MFD Disc Cap, 500V	4	900-921-04	Sprague		
C5	10 MFD 35V Tantalum	1	916-010-35	Sprague		
CR1 thru CR5	1N914 Diode	6	961-091-40	Teledyne	1N914	2
CR6	1N751A Diode	1	961-075-11	Teledyne	1N751A	1
CR7	1N914 Diode		961-091-40	Teledyne	1N914	
Q1	2N4250 Transistor	1	962-425-00	Solitron	2N4250	1
Q2	2N3415 Transistor	1	962-341-50	G.E.	2N3415	1
R1	18K ¼W 5%	1	942-201-83	Allen Bradley		
R2 thru R4	220 ohm ¼W 5%	4	942-202-21	Allen Bradley		
R5	470 ohm ¼W 5%	1	942-204-71	Allen Bradley		
R8	220 ohm ¼W 5%		942-202-21	Allen Bradley		
R9	3.3K ¼W 5%	1	942-203-32	Allen Bradley		
Z1,Z2	MC840P Hex Inverter	2	965-522-00	Motorola	MC840P	1
Z3 thru Z6	HP4350 Optical Isolator	4	965-570-00	Hewlett-Packard	HP4350	2

FIGURE 8-4. ANALOG OUTPUT BOARD (OPTION 13) ASSEMBLY 300-4981-02

REF DES	DESCRIPTION	QTY	DORIC P/N	MFG and P/N		REC SPARES
C1	1MFD 50V Polycarbonate	1	911-031-06	IMB	BA2A105	1
C2	.068 MFD 100V Polycarbonate	2	911-036-83	IMB	BA2B683	1
C3	.022 MFD 100V Polycarbonate	1	911-032-23	IMB	BA2B223	1
C4	.047 MFD 50V Polycarbonate	1	911-034-73	IMB	BA2A473	1
C5	22MFD 35V Tantalum	2	916-220-05	Sprague	196D226X0035	1
C6	2.0 MFD 100V Polycarbonate	1	911-032-05	IMB	BA2B205	1
C7	.068 MFD 100V Polycarbonate		9211-036-83	IMB	BA2B683	
C8	22MFD 35V Tantalum		916-220-05	Sprague	196D226X0035	
C9	.56 MFD 100V Polycarbonate	1	911-035-64	IMB	BA2B564	1
C10	2.2 MFD 35V Tantalum	1	916-220-04	Sprague	196D225X0035	
C11	Cap .1 MFD Tantalum	1	916-031-05	Sprague	196D104X	1
C12,C13	510PF Duramica Cap	2	915-035-11	Sprague	DM1511	1
C17	.001 MFD Disc Cap, 1000V	1	900-081-03	Sprague		
CR1 thru CR4	1N457A Diode	4	961-045-70	Teledyne	1N457A	2
CR5 thru CR10	1N914 Diode	6	961-091-40	Teledyne	1N914	2
F1	1/32 Amp 3AG Normal Blow 312.03	1	971-070-10	Littlefuse		1
R1	680 ohm ½W 5%	1	942-306-81	Allen Bradley		
R2	1 MEG ¼W 5%	1	942-201-05	Allen Bradley		
R3	10 MEG ¼W 5%	1	942-201-06	Allen Bradley		
R4	150 ohm ¼W 5%	2	942-201-51	Allen Bradley		
R5	10 ohm ¼W 5%	1	942-201-00	Allen Bradley		
R6	150 ohm ¼W 5%		942-201-51	Allen Bradley		
R7	100K Pot Cermet	1	960-011-09	Beckman	89PR100K	1
R8	39 ohm ¼W 5%	1	942-203-90	Allen Bradley		
R9	22K ¼W 5%	2	942-202-23	Allen Bradley		
R10	30.781K .05% WW	1	934-211-98	Jordan	J-115	
R11	2K Pot Cermet	1	960-012-06	Beckman	89PR2K	1
R12	649 ohm .05% WW	1	934-211-99	Jordan	J-115	
R14	10K ¼W 5%	1	942-201-03	Allen Bradley		
R15	68 ohm ¼W 5%	1	942-206-80	Allen Bradley		
R16	5K Pot Beckman 91Z	1	960-015-02	Beckman	91Z5K	1
R17	100K 1% RN60C	2	920-410-03	Dale		
R18	50K. 05% WW	2	934-211-97	Jordan	J-115	
R19	100K .05% WW	2	934-211-96	Jordan	J-115	
R20	50K .05% WW		934-211-97	Jordan	J-115	
R21	100K .05% WW		934-211-96	Jordan	J-115	
R22	4.7 MEG ¼W 5%	1	942-204-75	Allen Bradley		
R23	51 ohm ¼W 5%	1	942-205-10	Allen Bradley		
R24	22K ¼W 5%	2	942-202-23	Allen Bradley		
R30	10K Pot Cermet	1	960-011-05	Beckman	89PR10K	1
R31	1 MEG 1% RN60C	1	920-410-04	Dale		
R32	1.21K 1% RN60C	1	920-412-11	Dale		
R33	5K Pot Beckman 91Z	2	960-015-02	Beckman	91Z5K	1
R36	20K 1% RN60C	1	920-420-02	Dale		
R37	10K 1% RN60C	1	920-410-02	Dale		
R40	100K 1% RN60C		920-410-03	Dale		
Z1	725 OP Amp	1	965-504-00	Fairchild	725	1
Z2 thru Z4	741C OP Amp	3	965-506-00	Fairchild	741C	1
Z5	Fairchild 7818 18V Regulator	1	965-550-00	UGH7818	1	

FIGURE 8-5. ANALOG OUTPUT BOARD (OPTION 13-1) ASSEMBLY 300-4980-03

REF DES	DESCRIPTION	QTY	DORIC P/N	MFG and P/N		REC SPARES
C1	.1 MFD 50V Polycarbonate	1	911-031-05	IMB	BA2A104	1
C2	.068 MFD 100V Polycarbonate	2	911-036-83	IMB	BA2B683	1
C5	22MFD 35V Tantalum	3	916-220-05	Sprague	196D226X0035	1
C7	.068 MFD 100V Polycarbonate		911-036-83	BA2B683		
C8	22 MFD 35V Tantalum		916-220-05	Sprague	196D226X0035	
C9	.56 MFD 100V Polycarbonate	1	911-035-64	IMB	BA2B564	1
C10	2.2 MFD 35V Tantalum	1	916-220-04	Sprague	19D225X0035	1
C11	.1 MFD 50V Polycarbonate	1	911-031-05	IMB	BA2A105	1
C12,C13	510PF Duramica Cap	2	915-035-11	Sprague	DM15511	1
C14	.22 MFD 100V Polycarbonate	1	911-032-24	IMB	BA2B224	1
C17	.001 MFD Disc Cap, 1000B	1	900-081-03	Sprague		
C19	22MFD 35V Tantalum		916-220-05	Sprague		
C1 thru CR4	1N457A Diode	4	961-045-70	Teledyne	1N457A	2
CR7 thru CR10	1N914 Diode	4	961-091-40	Teledyne	1N914	2
F1	1/32 Amp 3AG Normal Blow 312.03	1	971-070-10	Littlefuse		1
R1	680 ohm ½W 5%	1	942-306-81	Allen Bradley		
R2	1 MEG ¼W 5%	1	942-201-05	Allen Bradley		
R4	150 ohm ¼W 5%	2	942-201-51	Allen Bradley		
R6	150 ohm ¼W 5%		942-201-51	Allen Bradley		
R10	30.78K .05% WW	1	934-211-98	Jordan Elec.	J-115	
R11	2K Pot Cermet	1	960-012-06	Beckman	89PR2K	1
R12	649 ohm .05% WW	1	934-211-99	Jordan Elec.	J-115	
R17	100K 1% RN60C	2	920-410-03	Dale		
R18	50K .05% WW	2	934-211-97	Jordan Elec.	J-115	
R19	100K .05%WW		934-211-96	Jordan Elec.	J-115	
R20	50K .05%WW		934-211-97	Jordan Elec.	J-115	
R21	100K .05% WW		934-211-96	Jordan Elec.	J-115	
R22	4.7 MEG ¼W 5%	1	942-204-75	Allen Bradley		
R23	5K Pot Beckman 91Z	1	960-015-02	Beckman	91Z5K	1
R24	22K ¼W 5%	1	942-202-23	Allen Bradley		
R29	50K Pot Cermet	1	960-015-04	Beckman	89PR50K	1
R30	10K Pot Cermet	1	960-011-05	Beckman	89PR10K	1
R31	1 MEG 1% RN60C	1	920-410-04	Dale		
R32	1.21K 1% RN60C	1	920-412-11	Dale		
R36	20K 1% RN60C	1	920-420-02	Dale		
R37	10K 1% RN60C	1	920-410-02	Dale		
R40	100K 1% RN60C		920-410-03	Dale		
Z1	3480J Amplifier	1	965-571-00	Burr-Brown	3480J	1
Z2 thru Z4	741C OP Amp	3	965-506-00	Fairchild	741C	2
Z5	Fairchild 7818 18V Regulator	1	965-550-00	Fairchild	UGH7818	1

FIGURE 8-6. MOTION DETECTOR BOARD (OPTION 18) ASSEMBLY 300-465-03

REF DES	DESCRIPTION	QTY	DORIC P/N	MFG and P/N		REC SPARES
C1	.001 MFD Disc Cap. 1000V	1	900-081-03	Sprague		
C2	.0015 MFD 200V Polycarbonate	1	911-031-55	IMB	BA2C152	1
C3	47 MFD 20V Tantalum	1	916-471-20	Sprague	196D476X0020	1
C4	.01 MFD Disc. Cap, 500V	5	900-021-04	Sprague		
C5,C6	2.2 MFD 35V Tantalum	2	916-220-04	Sprague	196D225X0035	1
C7	.22 MFD 100V Polycarbonate	1	911-032-24	IMB	BA2B224	1
C8 thru C11	.01 MFD Disc Cap, 500V		900-021-04	Sprague		
C18	360PF Duramica Cap	1	915-033-61	Sprague		
Q1	2N3415 Transistor	2	962-341-50	G.E.	2N3415	1
Q2	Fairchild 7805 5V Regulator	1	965-551-00	Fairchild	UHG7805	1
R1	100 ohm ¼W 5%	3	942-201-01	Allen Bradley		
R2	2.2 MEG ¼W 5%	1	942-202-25	Allen Bradley		
R4, R5	22K ¼W 5%	2	942-202-23	Allen Bradley		
R6, R7	100 ohm ¼W 5%		942-201-01	Allen Bradley		
R10	4.7K ¼W 5%	1	942-204-72	Allen Bradley		
S1,S2	BCD Switch API 435123-1	2	969-010-87			1
Z1	T7490 Counter	5	965-518-00	Texas Inst.	7490	2
Z2	SN74192N Up-Down BCD Counter	5	965-561-00	T.I.	74192N	2
Z3	T7410N 3-3 Input Nand	1	965-532-00	T.I.	7410N	1
Z4	T74107 JK Flip Flop	2	965-520-00	Texas Inst.	74107	1
Z5	T7490 Counter		965-518-00	Texas Inst.	7490	
Z6	SN74192N Up-Down BCD Counter		965-561-00	T.I.	74192N	
Z7	MC846P Quad-2 Input Nand	1	965-567-00	Motorola	MC846P	1
Z8	T7400N Quad 2 Input Nand	1	965-528-88	Texas Inst.	7400N	1
Z9	T7404N Hex Inverter	1	965-530-00	T.I.	7404N	1
Z10	T7490 Counter		965-518-00	Texas Inst.	7490	
Z11	SN74192N Up-Down BCD Counter		965-561-00	T.I.	74192N	
Z12	T74107 JK Flip Flop		965-520-00	Texas Inst.	74107	
Z13	SN74123N Dual One-Shot	1	965-562-00	T.I.	74123N	1
Z14	T7490 Counter		965-518-00	Texas Inst.	9490	
Z15	SN74192N Up-Down BCD Counter		965-561-00	T.I.	74192N	
Z16	XN7485N 4 Bit Comparator	2	965-560-00	T.I.	7485N	1
Z17	MC837P Hex Inverter	3	965-524-00	Motorola	MC837P	1
Z18	T7490 Counter		965-518-00	Texas Inst.	7490	
Z19	SN74192N Up-Down BCD Counter		965-561-00	T.I.	74192N	
Z20	SN7485N 4 Bit Comparator		965-560-00	T.I.	7485N	
Z21,Z22	MC837P Hex Inverter		965-524-00	Motorola	MC837P	

FIGURE 8-7. T2A DISPLAY BOARD, ASSEMBLY, 300-4740-02.

REF DES	DESCRIPTION	QTY	DORIC P/N	MFG and P/N		REC SPARES
C1,C2	.2MFD 50V	2	900-021-02			
CR1	1N5279B Diode, 180V Zener	1	961-527-92	Motorola	1N5279B	1
I1 thru I4	3 Digit Display	1	968-071-00	Beckman	SP353	1
I5 thru I7	4Digit Display	1	968-071-01	Beckman	SP 356	1
Q1	2N3628 Transistor	1	962-363-80	National	2N3638	1
Q2	2N5551 Transistor	1	962-555-10	National	2N5551	1
Q3	2N3439 Transistor	1	962-343-90	RCA	2N3439	1
R1	5.1K, 1/8W, 5%	1	942-151-01	Allen Bradley		
R2,R11	27K, 1/8W, 5%	2	942-127-02	Allen Bradley		1
R3	18K, 1/8W, 5%	1	942-118-02	Allen Bradley		
R4	180K, 1/8W, 5%	1	942-118-03	Allen Bradley		
R5,R7,R9	2.2I, 1/8W, 5%	8	942-122-01	Allen Bradley		1
R6,R8,R10	9.1K, 1/8W, 5%	6	942-191-01	Allen Bradley		
R11,R13,R15	2.2K, 1/8W, 5%		942-122-01	Allen Bradley		
R12,R14,R16	9.1K, 1/8W, 5%		942-191-01	Allen Bradley		
R17,R18	2.2K, 1/8W, 5%		942-122-01	Allen Bradley		
Z1	MM6309 PROM 256X8	1	965-635-30	Monolithic Memory	MM6309	*1
Z2	DS8889 Display Driver	1	965-577-03	National	DS8889	1
Z3 thru Z6	DS8880 Display Driver	4	965-577-00	National	DS8880	2
Z7,Z8	DS8884 Display Driver	2	965-577-02	National	DS8884	1
	T05 Transipad	1	992-010-50			**
	Socket for Flex Cable	40	992-010-78			**
	Socket For 20 Pin IC	1	922-010-28			**
	Turret Terminal	1	991-020-65			**
	PCB, 300T2A Display Board	1	300-2740-02			**

* Z1 PROM must be programmed by DORIC.

**Component without reference designator, order from DORIC if required.

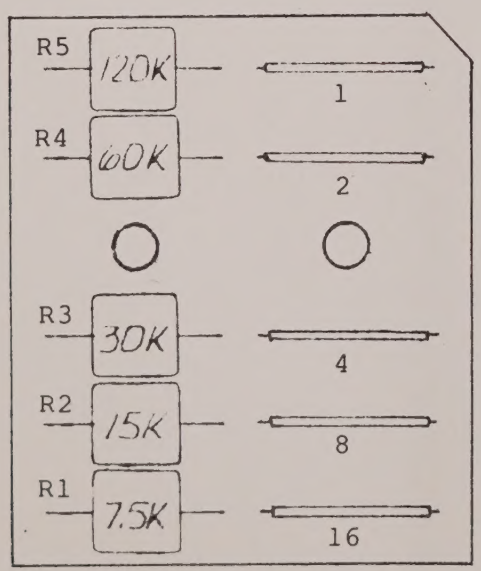
MANUAL ADDENDUM: OPTION 23, TARE BOARD (Assy. 815-4050-00)

An option is available which creates a more flexible way to attain additional offset.

Option 23 is a PCB assembly comprised of 5 precision resistors in a parallel arrangement. The total resistance of this network is jumper selectable to provide the additional required millivolt offset, which can be directly extrapolated from the jumpers remaining on the board and the value of the excitation voltage. The assembly mounts on the R +TH or R -TH terminals on the DS-300-T2 Plug-On Board, depending upon the desired compensation (offset).

Each jumper is assigned a particular numerical weight (in millivolts) and marked thus: 1,2,4,8, and 16. With a 10 volt excitation voltage, the jumpers are directly read in millivolts (e.g. 1mV, 2mV, 4mV, etc.). The jumpers are cut as required and those remaining are summed by its numerical weight to give the actual millivolts offset produced. A multiplication factor of the excitation voltage multiplied by .1 is required for the sum of the numerical weighted jumpers, to extrapolate the millivolts offset produced using other values of excitation voltage; (e.g. multiplication factors for 5, 15, and 20 volts are, .5, 1.5, and 2.0 respectively).

In most cases, no other resistor need be calculated. However, if the required offset is outside the range provided by the Tare Board, a external resistor may be calculated and installed on the pertinent terminals per 5.3 on page 5-2 of the owner's manual.



All resistors: .05% wirewound

OPTION 23, TARE BOARD ASSEMBLY 815-4050-00